Report of Geotechnical Investigation
Dam Safety Assessment of Coal Combustion Surface Impoundments
Minnesota Power
Boswell Energy Center, Cohasset, MN

AMEC Project No. 3-2106-0174.0300

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I certify that the management unit referenced herein:

ALLETE Inc, Minnesota Power, Boswell Energy Center: Complex (Pond 3, Pond 4, Bottom Ash Pond), Inactive Bottom Ash Pond, Waste Water Treatment Plant Basins.

Has been assessed on May 17th, 2010.

Signature ____
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Senior Geotechnical Engineer

List of AMEC Participants who have participated in the assessment of the management units and in preparation of the report:

- Chris Eger
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1.0 INTRODUCTION AND PROJECT DESCRIPTION

1.1 Introduction

AMEC was contracted by the United States Environmental Protection Agency (EPA), via contract BPA EP09W001702, to perform site assessments of selected coal combustion byproducts surface impoundments. As part of this contract with EPA, AMEC was assigned to perform a site assessment of ALLETE, Inc., Minnesota Power Company's Boswell Energy Center, which is located approximately one half mile west of Cohasset, Minnesota as shown on Figure 1, the Site Location and Vicinity Map.

A site visit to Boswell Energy Center was made by AMEC on May 17, 2010. The purpose of the visit was to perform visual observations, inventory coal combustion waste (CCW) surface impoundments, inspect the containment dikes, and collect relevant historical impoundment documentation.

AMEC engineers, Dave Ott, P.E. and Mary Swiderski, EIT, were accompanied during the site visit by the following individuals:

Table 1. Site Visit Attendees

Company or Organization	Name and Title
Minnesota Power Company	Robert Johnson, Fuel Services Manager
Minnesota Power Company	Matthew Lien, Civil Engineer
Allete, Inc.	Blake Francis, Supervisor, Water Quality and Waste Management
Barr Engineering Company	Thomas Radue, PE, Civil Engineer, Vice President

1.2 Project Background

CCW results from the power production processes at coal fired power plants like Minnesota Power's Boswell Energy Center. Impoundments (dams) are designed and constructed to provide storage and disposal for the CCW that is produced. Minnesota Power reported to the EPA that five units receive or have received liquid borne materials. These units include the following:

1. Inactive Bottom Ash Pond;
2. Waste Water Treatment Plant Basins;
3. Ponds 3 and 4;
4. Bottom Ash Pond; and,
5. Coal Pile Sump;

Although Minnesota Power indicated five units receive CCW, a total of three units were evaluated. The Inactive Bottom Ash Pond and the Waster Water Treatment Plant (WWTP) Basins were each assessed. Ponds 3 and 4 and the Bottom Ash Pond are three compartments separated by dividing dikes; these are considered one ash pond in terms of permitting and have been evaluated as such. This unit is referred to as the Active Ash Pond Complex. Per the NPDES permit, the Coal Pile Sump receives runoff from the yard and coal pile; however, the Coal Pile Sump is not a designated unit for storage or disposal of residuals or by-products from the combustion of coal. Stephen Hoffman with the EPA was consulted, and it was determined that this unit does not directly receive CCW; therefore it was not inspected.

The Safe Dams Program is the body within the Minnesota Department of Natural Resources (MNDNR) that defines the term dam, as well as regulates dam design, construction and repair. The Safe Dams Program also evaluates dams in order to assign a dam classification to each structure.

The term dam is defined by the Minnesota Administrative Rules as any artificial barrier, together with appurtenant works, which does or may impound water and/or waste materials containing water except:

A. Dams which are less than 25 feet in height and have storage capacity at maximum storage elevation of less than 50 acre-feet, which shall be exempt from dam safety permit requirements if they do not have potential for loss of life resulting from failure or misoperation;
B. Any artificial barrier which is not in excess of 6 feet in height regardless of storage capacity or which has a storage capacity not in excess of 15 acre-feet regardless of height;
C. Underground or elevated tanks to store water and/or waste;
D. Any artificial barrier constructed solely for the purpose of containment of sewage or biological treatment of wastewater which is under the jurisdiction of the Minnesota Pollution Control Agency;
E. United States owned dams;
F. Dikes and levees constructed for flood control purposes to divert flood waters and which are not intended to act as impoundment structures.

All existing and proposed dams are classified by MNDNR as either Class I (High Hazard), Class II (Significant Hazard), or Class III (Low Hazard). The Class I (High Hazard) classification is assigned to "*those dams where failure, misoperation, or other occurrences or conditions would probably result in any loss of life or serious hazard, or damage to health, main highways, high-value industrial or commercial properties, major public utilities, or serious direct or indirect economic loss to the public*." A Class II (Significant Hazard) classification indicates "*those dams where failure, misoperation, or other occurrences or conditions would probably result in possible health hazard or probable loss of high-value property, damage to secondary highways, railroads or other public utilities, or limited direct or indirect economic loss to the public other than described in Class III*." Finally, a Class III (Low Hazard) refers to "*those dams where failure, misoperation, or other occurrences or conditions would probably result in property losses restricted mainly to rural buildings and local county and township roads which are an essential part of the rural transportation system service the area involved*." These definitions are from the Minnesota Administrative Rules Chapter 6115 Public Water Resources, Part 6115.0320 and 6115.0340.

There are three existing ash ponds at Boswell Energy Center, the Active Ash Pond Complex, the Inactive Bottom Ash Pond, and the WWTP Basins. An inspection was completed by MNDNR on August 19, 2009 of the Active Ash Pond Complex and the Inactive Bottom Ash Pond. Jason Boyle, State Dam Safety Engineer, was present at the inspection and was contacted for clarification purposes during the writing of this report. MNDNR classified the Active Ash Pond Complex as a Significant Hazard, which will be inspected every four years.

MNDNR believes that "*loss-of life is not probable if the Dam should fail. In addition, failure of one pond is unlikely to cause the plant to shut down due to the ability to move discharge to an adjacent pond, failure is unlikely to overtop a major roadway, and if the power plant was forced to shut down, electricity could be purchased from other sources. Dam Safety also noted that the two closest downstream cities, Cohasset and Grand Rapids, use groundwater for municipal water supplies.*"

During the 2009 inspection, the Inactive Bottom Ash Pond was also assessed. Due to the significant storage and freeboard available, the pond was not considered to be a hazard. Although no documentation is available, Jason Boyle stated the Inactive Bottom Ash Pond is unclassified. The WWTP Basins are not inspected by MNDNR and are unclassified. Unclassified dams are not re-inventoried on any specific rotation to determine if their classification or status has changed.

The National Inventory of Dams (NID), administered by the U.S. Army Corps of Engineers (USACE), provides a hazard rating for many dams within the United States. The NID was contacted during the writing of this report and referred us to Jason Boyle with MNDNR. Mr. Boyle stated that MNDNR's classification is adopted by NID. The most recent submittal (prior to 2009) by MNDNR to the NID listed the Active Ash Pond Complex as a Low Hazard (Class III), therefore it is assumed the NID rating is currently Low, although no documentation has been provided to verify this, and will be elevated to Significant based on the 2009 inspection. The Inactive Bottom Ash Pond and the WWTP Basins are unclassified.

As part of the observations and evaluations performed at Boswell Energy Center, AMEC completed EPA's Coal Combustion Dam Inspection Checklists and Coal Combustion Waste (CCW) Impoundment Inspection Forms. Inspection forms for each CCW ash pond are presented in Appendix A. The Impoundment Inspection Forms include a section that assigns a "Hazard Potential" that is used to indicate what would occur following failure of an impoundment. "Hazard Potential" choices include "Less than Low," "Low," "Significant," and "High." Based on the site visit evaluation of the impoundments, AMEC engineers assigned a "Significant Hazard Potential" classification to each of the ash ponds. As defined on the Inspection Form, dams assigned a "Significant Hazard Potential" classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. "Significant Hazard Potential" classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

1.2.1 State Issued Permits

The Minnesota Pollution Control Agency has issued National Pollutant Discharge Elimination System (NDPES)/State Disposal System (SDS) Permit No. MN0001007 to Minnesota Power-Boswell Energy Center. This NPDES Permit authorizes the Minnesota Power Division of ALLETE, Inc. to discharge from Minnesota Power Boswell Energy Center to Pokegama Reservoir on the Mississippi River. The permit became effective on March 9, 2007 and is set to expire on February 29, 2012.

On August 3, 1956 the State Minnesota Department of Conservation issued Permit No. 56-197 for use in generation of electrical energy. The permit was amended February 22, 1971, May 8, 1978 and again on November 28, 1995 by the MNDNR for water appropriation and construction of a waste disposal system relative to the Clay Boswell Unit 4 Operations. The permit includes General and Specific Permit Terms and Conditions, to the Minnesota Power and Light Co for the Clay Boswell Unit 4 Operations. The permit remains in effect until November 1, 2014 contingent upon compliance with permit terms and conditions.

1.3 Site Description and Location

Minnesota Power's Boswell Energy Center is located in Itasca County, Minnesota, approximately one half mile west of the city of Cohasset. In 2008 the population of Cohasset was approximately 2,500. The area surrounding the south-eastern plant boundary is a mixture of industrial, commercial, and residential development. The Mississippi River is located directly adjacent to the facility's south side. The distance between the closest point of the ash ponds and the Mississippi River is approximately 500 feet in the case of the Active Ash Pond Complex, and 200 feet in the case of the Inactive Bottom Ash Pond. The distance from the closest point of the WWTP Basins and the nearest outfall to the Mississippi River is approximately 130 feet. The Site Plan, included as Figure 2, shows the location of the ash ponds on the site, and their proximity to the river.

An aerial photograph of the region indicating the location of Boswell Energy Center's ash ponds in relation to schools, hospitals, and other critical infrastructure located within approximately 5 miles down gradient of the ash ponds is included as Figure 3, the Critical Infrastructure Map. A table that provides names and coordinate data for the infrastructure is included on the map. Additionally, Boswell Energy Center is adjacent to several natural occurring wetlands, as shown in Figure 4.

1.4 Ash Ponds

Boswell Energy Center is a coal-fired steam electric generating station consisting of four units with a gross generating capacity of 1005 megawatts. The plant utilizes coal in the production of electricity. In this process, two types of ash are generated: fly ash and bottom ash. Currently, only the Active Ash Pond Complex is directly receiving ash. The Complex is comprised of three active ponds (Pond 3, 4, and the Bottom Ash Pond) separated into compartments by dividing dikes. Figure 2 illustrates pond locations.

Bottom ash, the heavier and coarser of the two types of ash, is transported from Units 1, 2, 3, and 4 through pipelines as wet slurry to the Bottom Ash Pond. Bottom ash will occasionally be transported dry for use in the dry ash fill construction in Pond 3. The bottom ash can also be discharged wet as needed into Pond 3 to facilitate dry ash fill activities. After settling, water is returned to the plant for reuse in sluicing bottom ash back to the pond. A portion of the clarified water is blown down to the Central Wastewater Treatment Facility, where it is combined with other plant process waters, pH adjusted, and filtered through single valve gravity sand and charcoal filters. The water is then discharged through permitted NPDES outfalls to the Mississippi River.

Pond 3 receives fly ash from Units 1, 2, and 3 as well as flue gas desulphurization (FGD) slurry from the Unit 3 absorber system. The fly ash is pneumatically conveyed from the plant to the fly ash silo and then deposited by truck into the landfill which is located in the west/northwest section of the pond. Bottom ash is used as cover for the dry ash landfill. After settling, the water from the FGD slurry is returned to the Unit 3 system as makeup for the scrubber processes during warmer months of the year. In cold weather months, the return water is not used to prevent line freeze-up. Bottom ash excavated from the Bottom Ash Pond is used as a cover for the dry ash landfill.

Pond 4 is a closed loop operation. The wet scrubber on Unit 4 removes particulates from the gas path with spray water from absorber tanks. A portion of this water/slurry is blown down from the absorber tanks to the waste slurry sump on Unit 4. This material is slurried to the Unit 4 FGD Pond where the solids settle out. The clarified water is returned to Unit 4 for re-use in the Unit 4 scrubber system.

The ash handling summary for the active ponds detailed above was compiled from a summary provided to AMEC by Minnesota Power and BARR's August 2007, Unit 3 Dry Ash Placement and Incremental Closure Plan.

Ash pond plan views and typical embankment cross sections are illustrated on Figures 6 through 10. Background information that is specific to each ash pond is presented in the following sections. More comprehensive information is provided in Section 2, Field Assessment.

1.4.1 Active Ash Pond Complex (Ash Pond 3, 4, and Bottom Ash Pond)

The Active Ash Pond Complex was designed by professional engineers from Ebasco Services, Inc. of Atlanta, Georgia. The Ebasco design report (dated April 1977) indicates the impoundments were designed for a plant life of 35 years at the current (1980) operating processes. On-site construction of the pond was supervised by a professional engineer from Ebasco and an internal Minnesota Power engineer. Operation of the Active Ash Pond Complex began in December 1979. The three ash ponds within the complex have an approximate total surface area of 645 acres. The embankment crest elevation for the complex is 1321.0, and the embankment height ranges from 7 to 45 feet. The approximate dike lengths are 19,800 feet and 8,300 feet along the outside perimeter and interior dikes, respectively. The embankment crest is 20 feet in width, and the exterior and interior slope angle is 3 horizontal to 1 vertical.

The three ponds were constructed from on-site random fill (silty sand), overlying sand and a natural clay deposit. A clay liner was constructed along the interior face of the ponds that varied in thickness from 3.2 feet at elevation 1317.0 (maximum pool elevation) to 10.0 feet at the toe of slope at the maximum dike height. The clay liner on the perimeter dikes is keyed into the underlying insitu clay deposit and has a hydraulic conductivity of 7.7×10^{-6} to 7.4×10^{-9} cm/sec. The natural and constructed clay liner along the base of the embankment ranges from 2 to 40 feet in thickness. Below is a more detailed description of each of the three ash ponds within the ash management system.

Pond 3

Pond 3 receives fly ash from Units 1, 2, and 3 and flue gas desulphurization slurry from the Unit 3 absorber system. Minnesota Power's Response to the EPA June 2009 Information request indicates the pond has a total storage capacity of 2,666 acre-feet (4,301,147 cubic yards (CY)), and estimates the in-place ash quantity is 1,041 acre-feet (1,679,480 CY). The corresponding surface area is 204 acres. The most current reading (May, 17, 2010) provided to AMEC indicates the pond has an elevation of 1305.00 feet above Mean Sea Level (MSL).

Due to a number of legislative and regulatory mandates, including EPA's Regional Haze Rule (RHR), the Clean Air Act Interstate Rule (CAIR), the Clean Air Mercury Rule (CAMR), and the Minnesota Mercury Emissions Reduction Act of 2006, upgrades to the emission control equipment for Unit 3 were required. The construction of the new Unit 3 scrubber and associated facilities began in April 2007 with a project in-service date of November 2009. Prior to the installation of the new scrubber system in 2009, Pond 3 accepted flyash from Unit 3. In this prior process the flyash settled in the pond and the excess pond water was discharged to the plant water intake structure. The current operating procedures for Pond 3 are described in Section 1.4. The NPDES Permit MN0001007 issued on March 9, 2007 to Minnesota Power requires Boswell Energy Center to incrementally cover ash placed above the delta area of Pond 3. A 25-year Incremental Closure Plan and Schedule is discussed in BARR's August 2007 Unit 3, Dry Ash Placement and Incremental Closure Plan.

Pond 4

Minnesota Power's Response to the EPA June 2009 Information request indicates Pond 4 has a total storage capacity of 7,190 acre-feet (11,599,866 CY), and estimates the in-place ash quantity is 3,182 acre-feet (5,133,627 CY). The corresponding surface area is 379 acres. The most current reading (May 17, 2010) provided to AMEC indicates the pond has an elevation of 1307.50 feet above MSL.

Prior to the upgrades to the Unit 3 scrubber described in Section 1.4.1 Pond 3, Pond 4 accepted flyash from Units 1, 2, and 4 and scrubber solids from Unit 4. The solids were transported as slurry through a pipeline. Excess water from Pond 4 was returned to the plant for use in Unit 4 scrubber system and for slurry transport of additional air emissions quality control equipment solids to Pond 4. See section 1.4 above for current ash pond processes.

Bottom Ash Pond

Minnesota Power's Response to the EPA June 2009 Information request indicates that the Bottom Ash Pond has a total storage capacity of 1,380 acre-feet (2,226,400 CY), and estimates the in-place ash quantity is 1,130 acre-feet (1,823,066 CY). The corresponding surface area is 62 acres. The most current reading (May 17, 2010) provided to AMEC indicates the pond has an elevation of 1308.50 feet above MSL.

1.4.2 Waste Water Treatment Plant Basins

The WWTP Basins were designed in December of 1977 by Ebasco Services. The treatment facility consists of four holding basins which each have a storage capacity of 2.3 acre-feet (3713 CY), a corresponding surface area of 1.6 acres, a maximum embankment height of 4 feet, and a maximum pond depth of 12 feet. The embankment crest elevation is 1301 feet, and the maximum pool elevation is 1299 feet. The basin side slopes are 2 horizontal to one vertical, the slopes at the end of each basin were designed as 3 horizontal to 1 vertical to allow access for cleaning equipments. A 6-inch compacted layer of crushed stone was placed along the slopes for erosion protection. The basins receive industrial plant process wastewater for primary settling, clarified water is routed to the Central Wastewater Treatment Plant for final treatment. The plants consist of a system of pumps, filter devices, and chemicals used to treat and adjust pH of industrial wastes prior to discharge to the river. The Bottom Ash Pond is the only ash pond that discharges into the WWTP Basins.

In order to control seepage, a vertical impervious cutoff trench was constructed around the basin. The trench extended from the crest of the perimeter and longitudinal dividing embankment to a depth of 2 feet into the natural clay layer (approximately 12 feet below ground surface). The trench is a minimum of 3 feet wide and was filled with compacted clay or bentonite slurry. A maximum hydraulic conductivity of 2.61×10^{-7} cm/sec was used for seepage calculations.

1.4.3 Inactive Bottom Ash Pond

The Inactive Bottom Ash Pond was operated from June 1973 through December 1979. The pond contains bottom ash, and a small designated area of the pond permanently contains permitted industrial solid waste, such as construction debris, sandblasting material and brick refractory. The Inactive Bottom Ash Pond was part of the "Old Unit 3" which included two ash management units separated by a dividing dike. The western half of the pond was referred to as the Unit 3 Fly Ash Pond. The Fly Ash pond is no longer considered an impoundment due to two 200-foot breaches in the perimeter dike located in the south and southwest embankment. The Bottom Ash Pond was the eastern one-half of the pond and is considered an inactive impoundment. Records do not indicate who originally designed and supervised construction of the pond. Minnesota Power's response to the EPA titled Enclosure 1, ALLETE, Inc. Boswell Energy Center EPA CERCLA Section 104 (e) Information Request for Surface Impoundments March 2009 states the bottom ash pond has a maximum dam height of 40 feet, surface area of 200 acres, has a storage capacity of 1513 acre-feet (2,440,973 CY) and a stored ash volume of 149 acre-feet (240,387 CY).

Ebasco's Minnesota Power Clay Boswell Pond Closure and Sealing Plan Unit #3 Fly and Bottom Ash Pond dated August 1981 was consulted for details regarding the pond construction. The 1981 report indicates the embankments were constructed with upstream slopes of 3 horizontal to 1 vertical and downstream slopes of 2 horizontal to 1 vertical. The embankment crest was set at elevation 1315 feet with an approximately 15 foot roadway width. The dividing dike between the two ponds, which currently serves as the Inactive Bottom Ash Pond's western dike, was constructed with a 1-1/2 horizontal to 1 vertical slope on both the upstream and downstream slopes. Figures 11 and 12 illustrate the Inactive Bottom Ash Pond Plan View and Typical Cross Sections. During the initial filling of the bottom ash pond, instability of the dividing dike was noted and a downstream berm was constructed to increase the effective slope, increasing the stability of the embankment. Riprap was used to increase the stability of the upstream slope.

Ebasco's August 1981 report was consulted for details regarding the pond closure. The bottom ash pond was sealed to provide future storage capacity. The seal consisted of a soil-bentonite slurry trench cutoff wall extending through the embankment and foundation sands and keying into the natural clay stratum which underlies the entire pond. The bottom ash seepage rate at maximum pool elevation was calculated to be 446 gallons/acre/day. The stability of the embankment during construction of the slurry trench was reviewed and was not considered to be decreased by construction activities. During closure activities, the existing embankment crest was too narrow to support the trenching equipment and was lowered by 2 feet to increase the width of the crest by approximately 10 feet. Prior to construction the backfill design was to be tested to ensure a long term coefficient of permeability not greater than $1x10^{-7}$ cm/sec. The top of the 4-inch crushed aggregate road surface was placed over the embankment crest. Currently, this pond is sealed, has significant excess storage capacity and freeboard, no longer receives liquid-borne material, and is considered inactive.

Following completion of the slurry trench, an area of approximately 2 acres in the northeast portion of the pond was used, with approval of the Minnesota Pollution Control Agency (MPCA), for disposal of non-hazardous wastes until December 2001. Additionally, beginning in October 1993, disposal of boiler dry coal ash just north of the non-hazardous site began, as specified in the MPCA-approved Old Bottom Ash Pond Disposal Plan. This site is referred to as the Hibbing Ash Cell. Approximately 5,000 tons of coal ash was transported annually by truck to the Ash Cell from October 1993 until December 2001, for an approximate total of 40,000 tons. Closure of this compartment was completed in October 2002 with MPCA approving final cover construction in December 2003.

1.5 Previously Identified Safety Issues

Discussions with plant personnel and review of provided documentation did not indicate any current or previously identified safety issues during the previous 5 years at Boswell Energy Center.

1.6 Site Geology

The September 2003, Dike and Foundation Studies and Construction prepared by William H. Stejskal provides information that describes the soil conditions of the area. According to the report, the site of the active complex units is "*situated on lake deposits formed by glacial Lake Aitkin, which occupied the Mississippi River Valley about 10,000 years ago. Soil deposits of this formation are composed of fine sand, silts, and clays. Glacial outwash deposits of sand, silt gravel, and some clay seams exist from the ground surface to depth of 90 feet in the west half of the old Unit 3 Fly Ash Pond and the southwest corner of the new Unit 3 Fly Ash Pond. This deposit, which extends from the west, slopes down to the east underneath continuous clayey silt to clay stratum, which ranges in thickness from 10 to 40 feet. Overlying the clay stratum in this area is a silt deposit, which ranges in thickness from 10 to 20 feet.*"

The November 1997 Unit No. 4 Dike and Foundation Studies prepared by Ebasco Services describes the bedrock within the plant area. According to the report "*bedrock is composed of granite associated with Giants (Mesabi) Range batholith covered by more than 200 feet of till. At the plant site, bedrock was encountered at 265 feet depth.*"

1.7 Inventory of Provided Materials

ALLETE/Minnesota Power provided AMEC with numerous documents pertaining to the design and operation of Boswell Energy Center. These documents were used in the preparation of this report and are listed in Appendix F, Inventory of Provided Materials.

2.0 FIELD ASSESSMENT

2.1 Visual Observations

AMEC performed visual observations of Boswell Energy Center's Ash Ponds including the Active Ash Pond Complex, the Waste Water Treatment Plant Basins, and the Inactive Bottom Ash Pond. Assessment of the ash ponds was completed in general accordance with *FEMA's Federal Guidelines for Dam Safety, Hazard Potential Classification System for Dams, April 2004*. The EPA Coal Combustion Dam Inspection Checklist and Coal Combustion Waste (CCW) Impoundment Inspection Form were completed for each ash pond during the site visit. These completed forms were provided to the EPA via email five business days following the site visit. (Refer to Appendix A for copies of the completed checklist forms). Additionally, photographs were taken of each impoundment during the site visit. The photo log, descriptions, and photo location site maps for each ash pond can be found in Appendix B. Rainfall data for the Cohasset, Minnesota area was collected for the 30 days prior to the site visit. Table 2, below, summarizes the rainfall data for the days immediately preceding AMEC's site visit.

Table 2. Plant Boswell Energy Center Rainfall Data

Rainfall Prior to Site Visit	
Date	**Rainfall (in.)**
May 9, 2010	0.0
May 10, 2010	0.0
May 11, 2010	0.26
May 12, 2010	0.02
May 13, 2010	0.49
May 14, 2010	0.02
May 15, 2010	0.0
May 16, 2010	0.0
Total (7 days prior to visit)	**0.79**
Total (30 days prior to visit)	**2.35**

2.2 Visual Observations - Active Ash Pond Complex

The Active Ash Pond Complex was put into operation in December 1979, and is an ash management system comprised of three ash pond compartments with dividing dikes. The Complex is considered one unit. In the event of an interior dike failure, the perimeter dikes would contain the breached material; therefore the interior dikes of the pond were not inspected by AMEC.

Each pond is used for different purposes in the ash handling process. Pond 3 currently receives flyash and bottom ash from Units 1, 2, and 3 and FGD slurry from the Unit 3 absorber system. Pond 4 receives FGD slurry from Unit 4. The Bottom Ash Pond receives slurry bottom ash from all four generating units and a portion of the industrial stormwater flow.

2.2.1 Active Ash Pond Complex - Embankments and Crest

The Active Ash Pond Complex is a diked configuration with embankment heights varying from 7 to 45 feet, with a crest elevation of 1321.0. The complex has an approximate surface area of 645 acres; the ponds have estimated areas of 204 acres, 379 acres, and 62 acres for Pond 3, 4 and the Bottom Ash Pond, respectively. At the time of the site visit there was approximately 12.5 feet of freeboard within the ponds. In general, the downstream embankment surface varied from recently mowed to being covered with moderate vegetation (photos 1-4, 1-9, 1-15,1-19, 1-20, and 1-21).

The Active Ash Pond Complex has natural occurring wetlands adjacent to and immediately downstream of the Ponds (see Figure 4). During the site visit, several wet areas were noted along the downstream toe (photos 1-12, 1-16). In response to the 2009 MNDNR inspection, Boswell Energy Center cleared brush and trees from the downstream toe area in order to aid in visual observations for seepage (photos 1-10, 1-12, and 1-17).

A swale was noticed along the southern downstream slope (photo 1-15). On-site personnel believe this to be the result of local wildlife.

Erosion repair efforts were noted along the interior of the perimeters dikes (photos 1-34, 1-35, and 1-36). According to interoffice Minnesota Power emails, dike repairs were completed in May 2008 and June 2009. The affected areas include Pond 3, southeastern perimeter dike, Pond 4 northern, northeastern and eastern perimeter dike, and southwestern interior dike. The Bottom Ash Pond was in need of repair along the southern perimeter dike, and northeastern interior dike. Repair areas varied in size from 30 feet to 2100 feet in length, 4 feet to 45 feet in width, and 1 foot to 4 feet in depth. At the time of the inspection, wave action erosion was evident on the inside face of certain segments of the dikes.

A study was performed by BARR Engineering Co. to investigate cracks noted along the ash pond interior and perimeter dikes in April 2008. Longitudinal and transverse cracks were observed in size varying from hairline (visible upon close examination) cracks to those as wide as 1.5 inches. In terms of the perimeter dikes, cracks were noted along the northern segment of the west dike of Pond 3. Both transverse and longitudinal cracks were observed, ranging in width from hairline to 0.25 inch. It was BARR's opinion that the cracking was a result of frost action and higher water levels; periodic visual inspections of the areas were recommended.

2.2.2 Active Ash Pond Complex - Outlet Control Structure

The three ponds utilize reinforced concrete decant structures where water is removed from the ponds and returned to the plant for reuse and/or treatment and permitted discharge.

Pond 3 ash pond piping was recently replaced under the November 2009 Unit 3 retrofit project. The current pipe size is a 4-inch SDR 17 HDPE pipe. Per the plant's NPDES permit, Pond 3 is authorized to recycle to the Unit 3 Scrubber System. The water is returned to the Unit 3 system for makeup for the scrubber processes during the warmer months of the year. In cold weather months, return water is not used to prevent line freeze up.

Pond 4 is a closed loop operation, permitted to discharge clarified water for re-use into the Unit 4 Scrubber system. The return piping is a 10-inch SDR 17 HDPE pipe. The decant structure for Pond 4 can be seen in photos 1-37 and 1-38.

The Bottom Ash Pond is permitted to discharge to Units 1-4 Bottom Ash System and the Waste Water Treatment Plant. Clarified water is returned to the plant for reuse in sluicing bottom ash to the pond, a portion of this water is blown down to the Waste Water Treatment Plant, where it is treated and discharged to the Mississippi River. The return piping consists of a 14-inch schedule 40 carbon steel pipe. The decant outet is shown in photo 1-39.

2.3 Visual Observations - Waste Water Treatment Plant Basins

The WWTP Basins were designed by Ebasco Services, Inc in December 1977. The plant includes four holding basins which are used as temporary storage and treatment of wastewater from the plant and plant site prior to treatment by the WWTP.

2.3.1 Waste Water Treatment Plant Basins - Embankments and Crest

The WWTP Basins are diked and incised structures with a 4-foot high embankment. The freeboard at the time of the site visit was approximately 6 feet (photos 2-1 and 2-2). The dikes appeared to be maintained and mowed.

2.3.2 Waste Water Treatment Plant Basins - Outlet Control Structure

The WWTP Basins discharge to the WWTP. The WWTP is permitted to discharge to outfall SD 004 to the Mississippi River. The submerged piping from the WWTP Basins consists of a 24-inch STD carbon steel pipe. The referenced outfall is located approximately 130 feet south of the treatment ponds.

2.4 Visual Observations - Inactive Bottom Ash Pond

The Inactive Bottom Ash Pond began operation in 1973 was closed in 1981, is inactive, and no longer receives liquid-borne materials. The pond contained some water from previous rainfall events at the time of the site assessment. The previously utilized industrial solid waste areas and closed Hibbing Ash Cell were also observed (photos 3-1, 3-2, 3-3, and 3-4).

2.4.1 Inactive Bottom Ash - Embankments and Crest

The Inactive Bottom Ash Pond has a 26.7-foot high, diked embankment. The pool had approximately 22 feet of freeboard at the time of the site visit (photo 3-14). Water within the structure was assumed to be runoff from recent rain events. The northeast and northwest portion of the ash in the pond is covered with grass (photos 3-1, 3-2, 3-3, 3-4, and 3-6). Steep interior dikes were noted along the northeast dike (photo 3-14). The dikes appeared to be maintained and mowed.

2.4.2 Inactive Bottom Ash - Outlet Control Structure

The Inactive Bottom Ash Pond does not have outlet control structures.

2.5 Monitoring Instrumentation

Monitoring Wells

At total of 36 monitoring wells are located around the perimeter of the Boswell Energy Center, as well as along an interior dike between Ponds 3 and 4. The wells are monitored three times a year by an outside contract lab certified by the Minnesota Department of Health. Well locations are provided in Figure 5, corresponding data charts of water elevations created by AMEC from data provided by Minnesota Power can be found in Appendix C. Details of the well location and water elevations can be found in Table 3. A summary of water level elevations for the previous five years was provided by Minnesota Power. The summary includes one reading for each well for the past five years (if available). AMEC was not provided with specific dates for the recorded readings; therefore, it is unknown if the readings were recorded at the same time each year. Since water levels readings are affected by seasonal variations, the fluctuations in readings from year to year cannot be attributed to specific events without additional data.

In terms of the Operating Ash Pond Group wells, the water levels appear to be consistent over the previous five years with the exception of A180S which is located along the eastern downstream toe of the active ash pond complex, and A178S which is north of Blackwater Lake. The two wells show an increase in water levels during the 2008 and 2009 year. The sharp increase in well A180S may be an anomaly, as the surrounding wells do not exhibit similar behavior. Readings for 2010 have not been recorded for these wells; therefore, it is recommended that plant personnel further monitor the water levels to determine if this behavior is representative of the water elevation or if the reading was an anomaly.

The water levels for the reclaimed/upgraded ash pond group wells appear to generally exhibit consistent behavior over the previous five years, which the exception of wells A9D, HZ1D, and A1D which are declining over time. The three wells are located (respectively), north of the reclaimed flyash pond, along the western downstream toe of the Inactive Bottom Ash Pond, and along the southern downstream toe of the Active Ash Pond Complex, generally in the same vicinity of each other.

Table 3. Boswell Energy Center Monitoring Well Data

Monitoring Well ID	Location	Most Recent Water Surface Elevation
Operating Ash Pond Group		
NA 186 Shallow (S)/Deep(D)	Active Ash Pond Complex Southeastern Downstream Toe	1273.99 (S), 1274.03 (D)
NA 187 S/D	Active Ash Pond Complex Northern Downstream Toe	1283.22 (S), 1268.83 (D)
NA69	Active Ash Pond Complex Western Downstream Toe	1269.12
A174 S/D	Active Ash Pond Complex Eastern Downstream Toe	1281.50 (S), 1275.46 (D)
A177 S	Eastern Plant Location	1288.82
NA177 D	Eastern Plant Location	1275.43
A178 S/D	Located north of Blackwater Lake	1306.10 (S), 1288.35 (D)
A180 S/D	Active Ash Pond Complex Eastern Downstream Toe	1324.10 (S) 1277.33 (D)
NA181 S	Active Ash Pond Complex Northeastern Downstream Toe	1287.29
A181 D	Active Ash Pond Complex Northeastern Downstream Toe	1277.28
A182 S/D	Active Ash Pond Complex Northwestern Downstream Toe	1294.76 (S), 1289.97 (D)
A183 S/D	Active Ash Pond Complex Eastern Downstream Toe	1297.73 (S), 1290.41 (D)
A185 S/D	Southern Interior Dike Along Pond 4	1303.92 (S), 1280.51 (D)
A184 D	Active Ash Pond Complex Western Downstream Toe	1287.55
A1S	Active Ash Pond Complex Downstream Toe	1290.98
Reclaimed/Upgraded Ash Pond Group		
A9 S/D	North of Reclaimed Flyash Pond	1304.50 (S), 1280.61 (D)
DM 17	Reclaimed Fly Ash Pond Southeastern Downstream Toe	1290.78
DM 22C	Inactive Bottom Ash Eastern Downstream Toe	1277.30
DM22 S/D	Inactive Bottom Ash Eastern Downstream Toe	1293.41 (S), 1275.33 (D)
HZ1 S/D	Inactive Bottom Ash Western Downstream Toe	1296.33 (S), 1284.48 (D)
NDM 11	Reclaimed Fly Ash Pond Western Downstream Toe	1272.93
NDM 15	Reclaimed Fly Ash Pond Southern Downstream Toe	1277.49
NDM 24 S/D	Inactive Bottom Ash Southern Downstream Toe	1296.00 (S), 1275.24 (D)
A1D	Active Ash Pond Complex Southern Downstream Toe	1283.19

Settlement Monuments

Ten monuments were installed in 1979 around the Active Ash Pond Complex. Typically they are monitored twice per year to measure horizontal and vertical movement of the dike. Movement monitoring locations and corresponding data graphs can be seen in Appendix D. In terms of vertical movement, 8 of the 10 monitoring stations (excluding M-1 and M-7) have settled less than six inches since installation in 1979. BARR's report Engineering Movement Monitoring Station Data Review (December, 2009) suggests the increased movement at M-1 (as of May 4, 2010 is 0.70 feet) is due to the addition of a pre-load ash fill and maintenance building structure in the Bottom Ash Pond in 2007. Station M-7 has exhibited upward movement (0.80 feet as of May 4, 2010), and may be the result of operator error, as the elevation change has been negligible since 1985.

Horizontal movement was also monitored from the monuments. BARR reports the maximum horizontal movement recorded in 1983 was 2.55 feet (between monuments M-1 to M-6); however, movement typically has been less than 1.50 feet. Historically, the greatest lateral movement has occurred at monuments M-6, M-7, and M-8, which are located along the northern to northeastern dike of Pond 4. Since 2000, the data appears to indicate an increase in the rate horizontal movement; however, a data gap from January 2003 to May 2006 could impact these observations.

3.0 DATA EVALUATION

3.1 Design Assumptions

AMEC has reviewed the design assumptions related to the design and analysis of the hydraulic adequacy and stability of the Active Ash Pond Complex Ash based on the results of our site visit and the historical impoundment information provided to us by Minnesota Power. The design assumptions are described in the following sections.

3.2 Hydrologic and Hydraulic Design

3.2.1 Active Ash Pond Complex - Hydrologic and Hydraulic Design

Minnesota Power provided AMEC with an evaluation summary of the effects of a "Standard Project Precipitation", which is 12 inches of precipitation for a 48-hour period. The summary was provided in Addendum 2, October, 1977 by Ebasco Services as part of the Ash Disposal Pond Dike and Foundation Studies. The report states that the pond will not impound any water from upstream drainage areas, any surface waters from the stream transecting the pond site, will be diverted around the north end of the ash pond by a drainage ditch. Therefore, the only water entering the ash pond will be from plant operations and precipitation. The following assumptions were assumed to exist simultaneously in order to determine the required freeboard for the ash pond.

a. The pond is filled to the maximum pool elevation of 1317;
b. An event of 12 inch of precipitation for a 48-hour period is sustained;
c. A wind of 50 miles per hour for a 1-hour duration.

Based on the above assumptions, the following dimensions were calculated:

a. Standard Project Precipitation	12 inches
b. Effective fetch for fly ash – SO_2 compartment	3,965 feet
c. Wave height for shallow water	1.6 feet
d. Wave runup	2.4 feet
e. Wind setup	0.45 feet

To prevent the waves from reaching the crest of the dike and overtopping, the freeboard must exceed the sum of the standard project precipitation (12 inches), wave runup, and wind setup totaling 3.85 feet. The crest elevation was set to 1321.0 feet, with a 6-inch roadway the elevation is 1321.5, which results in 4.5 feet of freeboard, which would be adequate to prevent wave overtopping.

3.2.2 Waste Water Treatment Plant Basins- Hydrologic and Hydraulic Design

No hydraulic requirements or hydrologic calculations for the Waste Water Treatment Plant Basins were provided to AMEC for review.

3.2.3 Inactive Bottom Ash Pond - Hydrologic and Hydraulic Design

No hydraulic requirements or hydrologic calculations for the Inactive Bottom Ash Pond were provided to AMEC for review.

3.3 Structural Adequacy & Stability

MNDNR outlines rules and regulations for dam safety in the Minnesota Administrative Rules, New Dams or Enlargements (6115.0410). The regulations state that the dam must be stable under all conditions of construction and operation. According to Mr. Boyle, MNDNR has adopted the US Army Corps of Engineers (USACE) and/or the Federal Energy Regulatory Commission (FERC) standards for determining acceptable safety factors for the earthen structures. Earthen embankments, when analyzed to determine safety factors can be considered to have acceptable stability if the analyses yield at least the minimum safety factors shown in Table 4, as outlined in FERC Engineering Guidelines for the Evaluation of Hydropower Projects, Chapter 4, Embankment Dams.

To analyze the structural adequacy and stability of the Ash Ponds at Boswell Energy Center, AMEC reviewed the material provided by Minnesota Power with respect to the load cases shown in Table 4. Factors of safety documented in the provided material were compared with those factors outlined in Table 4 to assist in determining whether the impoundments meet the requirements for acceptable stability.

Table 4. FERC Minimum Required Dam Safety Factors

Load Case	Required Minimum Factor of Safety
End of Construction	1.3
Steady State Seepage (Long-Term)	1.4
Steady State Seepage with Seismic Loading	1.0
Rapid Drawdown (Upstream)	1.1

3.3.1 Soil Properties used in the October 1977 Stability Analyses – Active Ash Pond Complex

An October 1977 Unit No. 4 Ash Pond Disposal Pond Dike and Foundation Studies Addendum No. 1 was completed by Ebasco Services, and included a slope stability analysis. The soil properties of unit weight, angle of internal friction, and cohesion used in the stability analyses were determined from triaxial shear testing performed on undisturbed samples of the foundation and engineered fill soils obtained during drilling in September 1975. The field investigation included 105 borings ranging from 25 to 150 feet in depth. The testing was performed by Dames and Moore Laboratory in accordance with current ASTM Standards at the time of testing. Specifically, triaxial tests performed on soil specimens included isotropically consolidated, undrained shear tests with pore pressure measurements, and unconsolidated, undrained tests. Selection of strength parameters for the stability analysis was based upon the results of the triaxial tests as well as the type of analysis. Specifically, drained and undrained results were used for long and short term loading conditions, respectively. The soil parameters utilized during the analysis are reproduced in Tables 5, 6 and 7.

Review of the provided laboratory triaxial tests could not confirm the soil parameters for the Random Fill (silty sand) profile. The cohesion value of 500 psf appears to be a higher than can be justified by the provided triaxial tests and is an unconservative value for longterm stability analyses for a silty sand (SM) material (both insitu and random fill). The friction angle value (phi=30°) seems to be somewhat lower than justified by the same laboratory results. We recommend this data be reviewed and potentially revised and the stability analyses updated.

Table 5. Active Ash Pond Complex West Dike Soil Properties

	CLAY Recompacted		RANDOM FILL (Silty Sand)		CLAY In-Situ		SAND In-Situ	
Case	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$
Undrained	1000	0	500	30	1200	0	0	40
Drained	500	20	500	30	500	20	0	40

Table 6. Active Ash Pond Complex East Dike Soil Properties

	CLAY Recompacted		RANDOM FILL (Silty Sand)		CLAY In-Situ		SILTY SAND In-Situ		SAND In-Situ	
Case	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$
Undrained	1000	0	500	30	900	0	500	30	0	40
Drained	500	20	500	30	350	20	500	30	0	40

Table 7. Active Ash Pond Complex Maximum Height Section Soil Properties

	CLAY Recompacted		RANDOM FILL (Silty Sand)		CLAY In-Situ		SILTY SAND In-Situ		SAND In-Situ		PEAT In-Situ	
Case	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$	$C_{(psf)}$	$\Phi_{(deg)}$
Undrained	1000	0	500	30	900	0	500	30	0	40	250	15
Drained	500	20	500	30	350	20	500	30	0	40	250	15

3.3.2 Active Ash Pond Complex - Structural Adequacy & Stability

Four embankment sections were analyzed for slope stability, and included: typical west side embankment, typical east side embankment, maximum height embankment east side, and maximum height embankment south side. Embankment cross section can be found in Appendix E. Each section was analyzed for static and pseudo-static conditions by both the slip circle analysis and the U.S. Army Corps of Engineers sliding wedge analysis.

The Simplified Bishop approach was used to perform the slip circle analysis. In this methodology a circular failure surface is assumed to form about a center of rotation. A search routine is contained in the program to find the worst possible radius and center of rotation yielding the circle with the lowest factor of safety. The method also considers a seismic loading in the analysis. Ebasco states the Bishop Solution is a conservative approach since shear resistance between slices is neglected, a factor which would tend to raise the factor of safety. Additionally, the components of the design earthquake acceleration are assumed to act in one direction with a constant magnitude over the entire slope for an infinite length of time, neglecting any oscillatory motion. The results of the slip circle analyses are presented in Appendix E.

The sliding wedge method consists of an active soil wedge moving against a neutral horizontal block and a passive resisting wedge. This method divides the potential mass of sliding material into two or three large block or wedges the upper wedge called the active wedge and the lower wedge called the passive wedge. In this analysis the failure planes selected did not contain a passive wedge. This method was also considered by the consultants to be conservative for the same reasons listed above for the slip circle analysis. The results of the sliding wedge analyses are presented in Appendix E.

Two sets of shear strength parameters were used in each analysis. Drained (effective) soil strength parameters were used to model long term static conditions in which pore pressure within the soil has had time to dissipate. Undrained strength parameters were used to model conditions where pore pressure have been built up due to relatively quick load application, which occurs during construction or dynamic loading.

The minimum factors of safety were based on normally accepted state and federal standards, such as the U.S. Army Corps of Engineers. The four sections were each evaluated under four model conditions. The results are presented in Table 8.

Table 8. Results of October 1977 Slope Stability Analysis

	Model Conditions			
Model Condition	**Long Term**	**Short Term**	**Construction**	**Seismic**
Soil Properties	**Drained**	**Undrained**	**Undrained**	**Undrained**
Type Analysis	**Static**	**Dynamic**	**Static**	**Dynamic**
Minimum Factor of Safety (From Table 7)	**1.4**	**1.1**	**1.3**	**1.0**
East Side Typical Section	1.88	1.19	1.53	1.09
West Side Typical Section	2.46	2.57	2.14	2.09
South Side Maximum Height	2.42	1.47	1.50	1.16
East Side Maximum Height	2.10	1.86	1.40	1.21

In all cases evaluated the minimum factor of safety is exceeded.

3.3.3 Waste Water Treatment Plant Basins - Structural Adequacy & Stability

No stability analysis was provided for the Waste Water Treatment Plant Basins.

3.3.4 Inactive Bottom Ash Pond - Structural Adequacy & Stability

No stability analysis was provided for the Inactive Bottom Ash Pond.

3.4 Foundation Conditions

Active Ash Pond Complex

The Active Ash Pond Complex was constructed of sand, silt and clay materials available at site. The sand was borrowed from the high ground west of the proposed pond location, and the clay was obtained from a borrow area from within the pond. Beneath the pond footprint, a natural clay layer was found to be continuous throughout the extended areas which varied in thickness from 11 to 31 feet. Generally, the clay is within 15 feet of the ground surface; however at two boring locations was found to be as deep as 20 and 34 feet below ground surface. The natural clay liner was found to be absent in the southwest corner of the ash disposal area, in areas such as this where the clay is not continuous, or where the clay is less than 3 feet thick, a 3 foot thick surface clay liner was constructed on the compacted original ground surface. The liner was extended from the embankment toe to the insitu clay layer. A key trench was constructed to tie the surface clay lining into the subsurface clay layer at a point where the insitu clay is a minimum of 3 feet thick.

Approximately 88 acres of peat deposits were found at the ground surface. Due to the potential for excessive consolidation of these samples, the peat was removed from the embankment foundation. In areas where the peat deposit was removed, the area was backfilled with a consolidated sand fill.

Underlying the natural clay layer, dense to very dense glaicial sand and gravel till is present. This layer was encountered from the bottom of the clay strata to the full depth of the deepest boring (150 feet).

Waste Water Treatment Plant Basins

During the subsurface exploration for the Water Treatment Plant Basins, the clay layer underlying the site of the proposed basins was encountered. The clay layer was approximately 12 feet from the ground surface and was found to be approximately 13 to 15 feet thick. Above the clay layer, mixtures of sand, silt and clay were encountered. The basins were constructed on approximately 1.5 feet of insitu sandy material over the natural clay layer.

Inactive Bottom Ash Pond

The Inactive Bottom Ash Pond is underlain by a continuous clay stratum. The clay thickness varies from approximately 10 to 40 feet, and is typically within 15 feet of the original ground surface along the embankment foundation.

3.5 Operations and Maintenance

Minnesota Power personnel inspect the Active Ash Pond Complex every four hours, the WWTP Basins every two hours, and the Inactive Bottom Ash Pond monthly (including the Hibbing Ash Cell and Industrial Solid Waste Disposal Facility). BARR Engineering began inspecting the ponds in 2009. Conversations with plant personnel and review of the 2009 BARR report indicate that Boswell Energy Center Ash Ponds are well operated and maintained. According to the reports, there have not been any safety issues that have occurred at the plant in the past five years of operation. The facility has occasional instances of erosion issues, minor slope sloughing, and animal borrows; however interoffice communication indicates the issues are addressed in a timely manner. The site visit and observation performed by AMEC in May 2010 showed no major operational or maintenance issues that needed to be addressed.

3.5.1 Instrumentation

Currently, there are a total of 36 monitoring wells installed throughout Boswell Energy Center, and 10 movement monuments located around the Active Ash Pond Complex. The monuments and wells will be used to guide operation and maintenance of the facility. Currently, the monitoring wells are read three times a year, and the monuments semi-annually.

3.5.2 State or Federal Inspections

The most recent inspection by MNDNR of Boswell Energy Center was completed in August, 2009. The inspection included the Active Ash Pond Complex and the Inactive Bottom Ash Pond. No major deficiencies were noted, and the Dams were noted to be in good condition and well maintained. Following the inspection, the classification for the Active Ash Pond Complex was raised from a Low Hazard to a Significant Hazard. The Inactive Bottom Ash Pond was not considered a hazard due to the high freeboard and remains unclassified. Significant Hazard Dams are inspected by MNDNR every four years.

4.0 COMMENTS AND RECOMMENDATIONS

4.1 Acknowledgement of Management Unit Conditions

I certify that the management unit referenced herein (Active Ash Pond Complex) was personally inspected by me and was found to be in the following condition: **Satisfactory**.

A satisfactory management unit is described as having no existing or potential management unit safety deficiencies that are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydraulic, seismic) in accordance with the applicable criteria. Minor maintenance items may be required.

I certify that the management units referenced herein (Waste Water Treatment Plant Basins and Inactive Bottom Ash Pond) were personally inspected by me and was found to be in the following condition: **Poor**.

A poor management unit safety is recognized for any deficiency in required loading conditions (static, hydraulic, seismic) in accordance with the applicable criteria. Remedial action is necessary. Poor also applies when further critical studies or investigations are needed to identify any potential dam safety deficiencies.

The Waste Water Treatment Plant Basins and Inactive Bottom Ash Pond are rated poor due to lack of analyses which would verify the units would be stable under required loading conditions.

Additional Information regarding recommendations for instrumentation and analyses can be found in Sections 4.2 through 4.5.

4.2 Hydrologic and Hydraulic Recommendations

Review of the Minnesota Administrative Rules for Dam Safety does not indicate storage is required within the pond for any specific rainfall event. Minnesota Power provided a hydrologic calculation summary showing that the 12-inch 48-hour rainfall event can be successfully contained using the wet storage capacity of the Active Ash Pond Complex.

AMEC recommends that Minnesota Power determine what rainfall event the Active Ash Pond Complex, Waste Water Treatment Plant Basins and Inactive Bottom Ash Pond are capable of containing. A more complete evaluation would determine the effect of the Probable Maximum Flood (PMF) event on the ash ponds and the Boswell Energy Center site.

4.3 Geotechnical and Stability Recommendations

AMEC recommends that a stability analyses be completed for the Inactive Bottom Ash Pond that includes the maximum design water levels and appropriate steady-state phreatic surfaces. Likewise, the stability analyses should consider all critical stages during the life of the facility, such as maximum pool area and any potential surcharges, as well as likely loading combinations. AMEC recommends that the slope stability analyses include slip surface optimization to allow for noncircular failure surfaces. Additionally, for the Waste Water Treatment Plant Basins, Minnesota Power should document the stability of the structure (for all critical stages), and provide design documentation to verify this, including a stability analysis, if appropriate.

4.4 Instrumentation Monitoring Recommendations

AMEC recommends additional instrumentation to monitor slope stability and landslide conditions. In order to monitor these parameters, Minnesota Power should install combination slope inclinometers and additional piezometers in the river side dike of each ash pond. These instruments may be installed within the same borehole. Routine monitoring should be established with corresponding elevations within the ash ponds at the time of the measurement in order to establish an understanding of the embankment behavior.

Due to the limited outflow capacities of the ponds, AMEC recommends Minnesota Power create an Emergency Action Plan in the event of the PMF or other significant event. The emergency action plan should relate pool elevation to specific response actions, identify potential emergency conditions and prescribe procedures to be followed to minimize damage.

4.5 Inspection Recommendations

AMEC has reviewed provided information and inspection records and determined that Minnesota Power has adequate inspection practices. We recommend that Minnesota Power continue the current inspection program and practices.

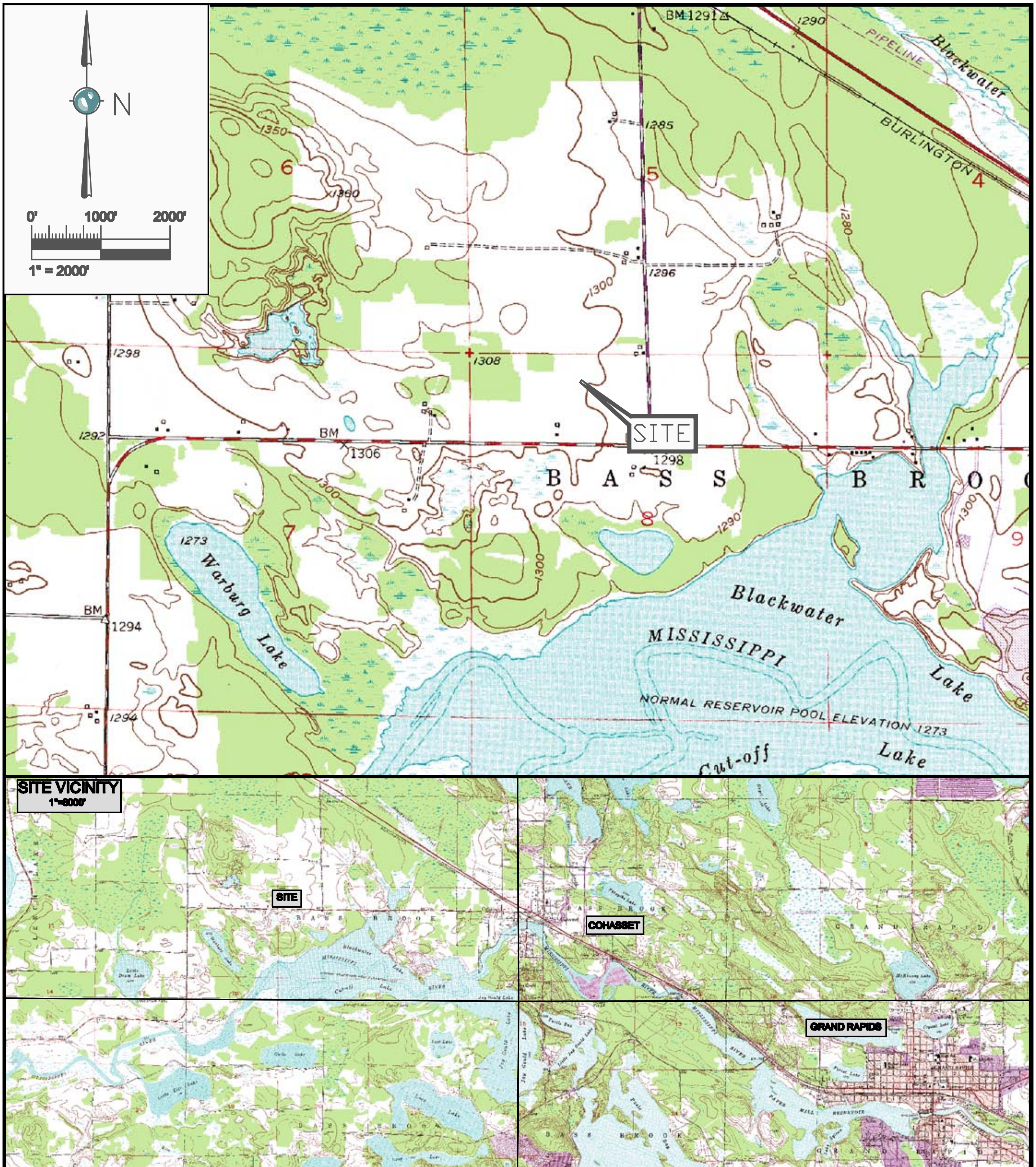
5.0 CLOSING

This report is prepared for the exclusive use of the Environmental Protection Agency for the site and criteria stipulated herein. This report does not address regulatory issues associated with storm water runoff, the identification and modification of regulated wetlands, or ground water recharge areas. Further, this report does not include review or analysis of environmental or regional geo-hydrologic aspects of the site, except as noted herein. Questions or interpretation regarding any portion of the report should be addressed directly by the geotechnical engineer.

Any use, reliance on, or decisions to be made based on this report by a third party are the responsibility of such third parties. AMEC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The conclusions and recommendations given in this report are based on visual observations, our partial knowledge of the history of Boswell Energy Center impoundments, and information provided to us by others. This report has been prepared in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

FIGURES



AMEC Earth & Environmental

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amec

CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/2/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN SITE LOCATION & VICINITY MAP	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE: AS SHOWN	FIGURE No. 1

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\March 2010 RFP Pro\Allete\Plant Boswell\Figures\fig1-siteandloc.dwg — Layout1 — Jun. 11, 2010 1:19pm — chris.eger

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

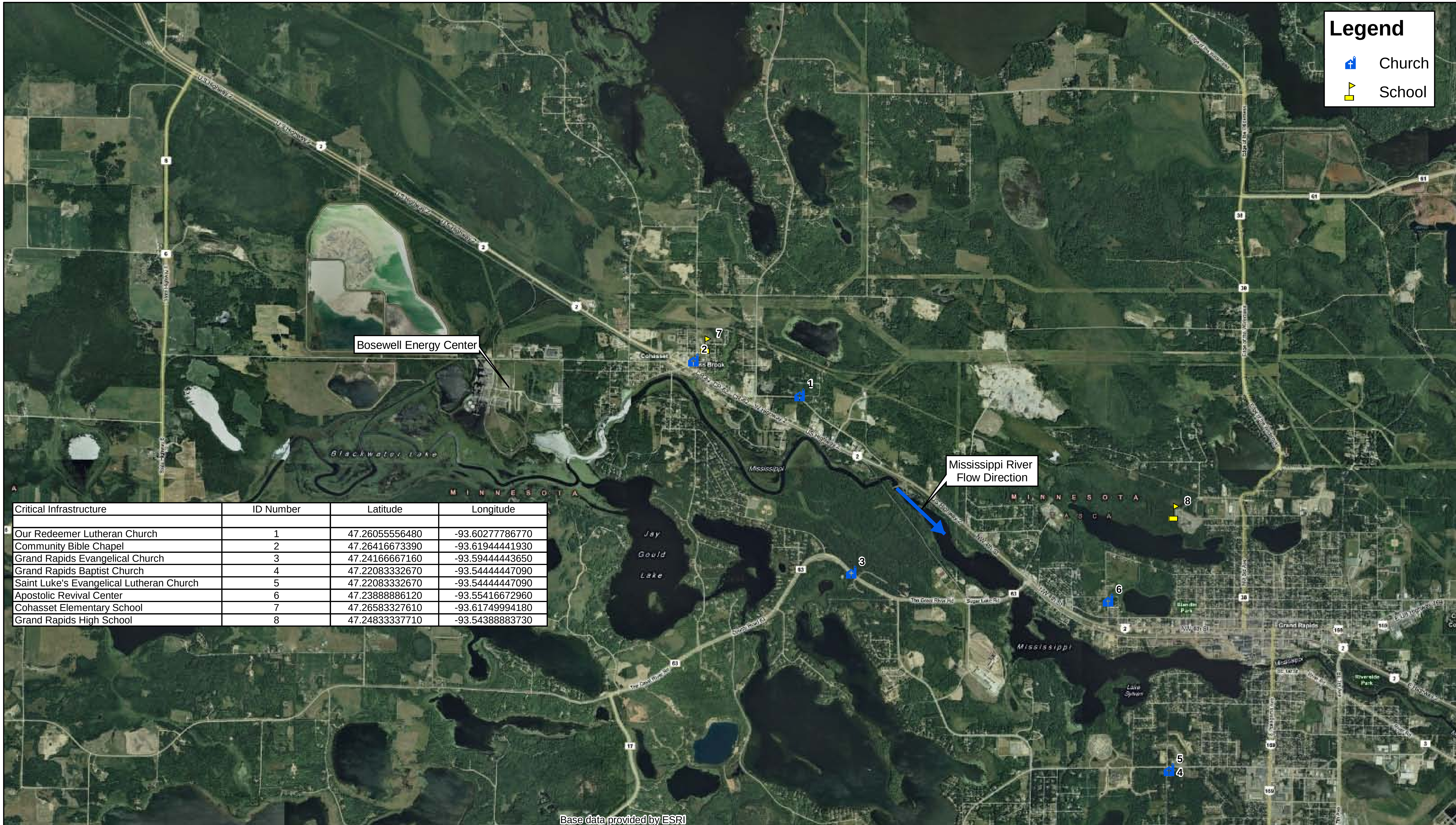
AMEC Earth & Environmental
690 Commonwealth Business Center
11003 Bluegrass Parkway
Louisville, KY 40299

DWN BY: ATJ
DWN BY: MS
Datum: NAD 83
Projection: Albers
Scale: As Shown

ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
SITE PLAN

REV. No.: A
Date: 6-14-2010
Project No: 3-2106-0174-0300
Figure No: 2



Critical Infrastructure	ID Number	Latitude	Longitude
Our Redeemer Lutheran Church	1	47.26055556480	-93.60277786770
Community Bible Chapel	2	47.26416673390	-93.61944441930
Grand Rapids Evangelical Church	3	47.24166667160	-93.59444443650
Grand Rapids Baptist Church	4	47.22083332670	-93.54444447090
Saint Luke's Evangelical Lutheran Church	5	47.22083332670	-93.54444447090
Apostolic Revival Center	6	47.23888886120	-93.55416672960
Cohasset Elementary School	7	47.26583327610	-93.61749994180
Grand Rapids High School	8	47.24833337710	-93.54388883730

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11003 Bluegrass Parkway
Louisville, KY 40299

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

DRAWN BY: ATJ
CHK'D BY: MS
DATUM: NAD83
PROJECTION: Albers
SCALE: AS SHOWN
DATE: 5/21/2010

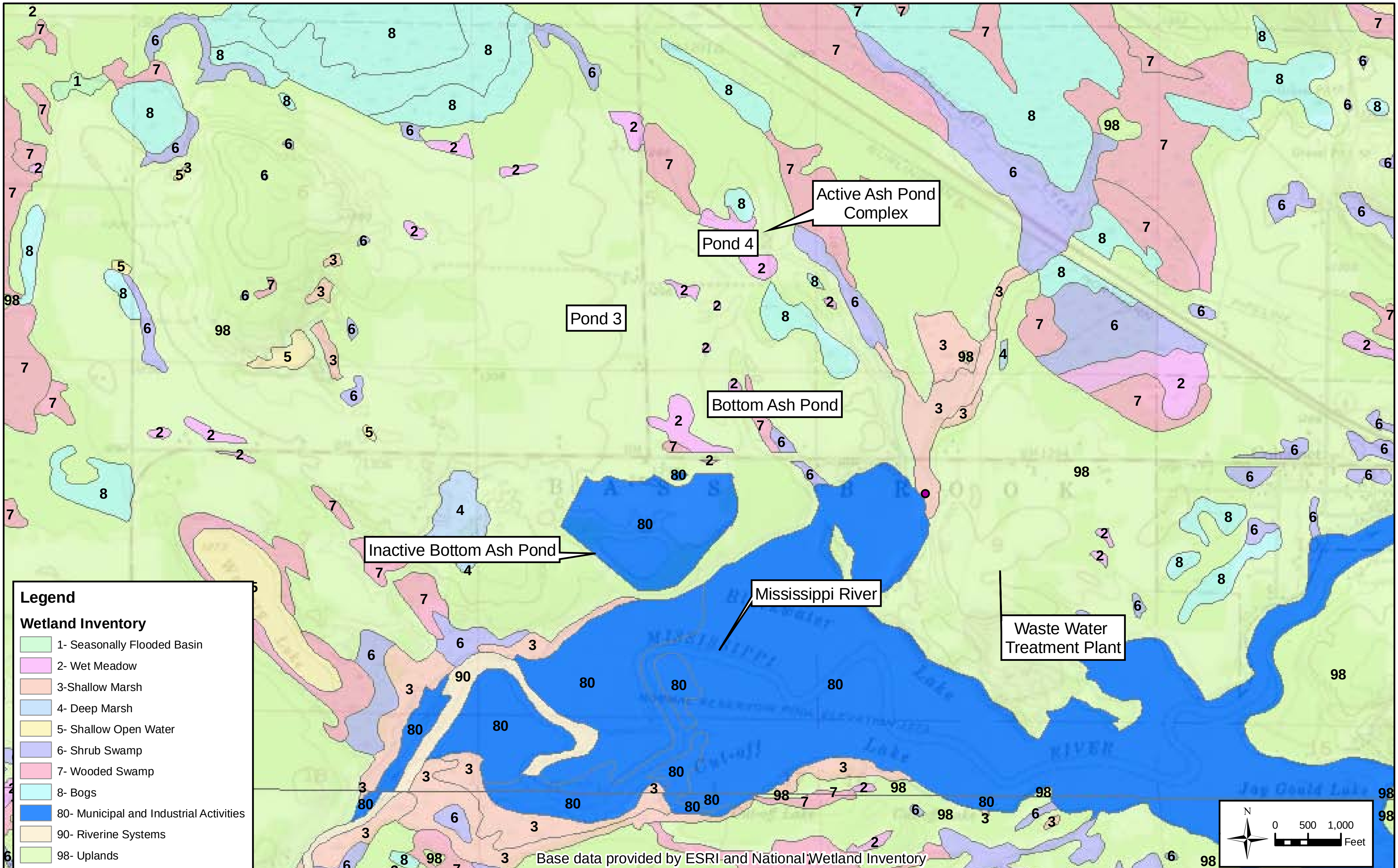
ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
CRITICAL INFRASTRUCTURE

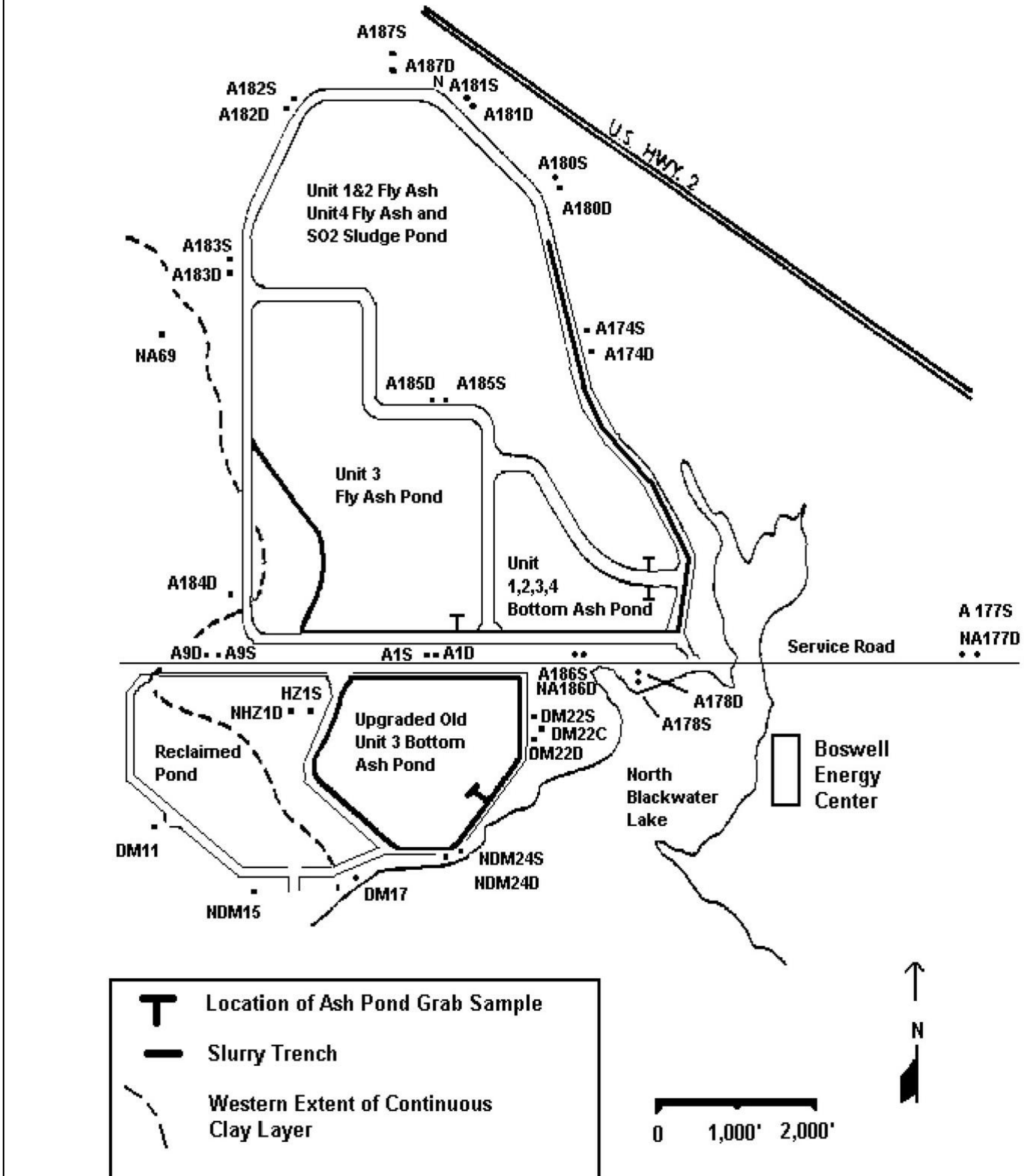
N
0 0.5 Miles
0 1 Kilometers

Notes: Critical infrastructure data provided by ESRI

FIGURE
3

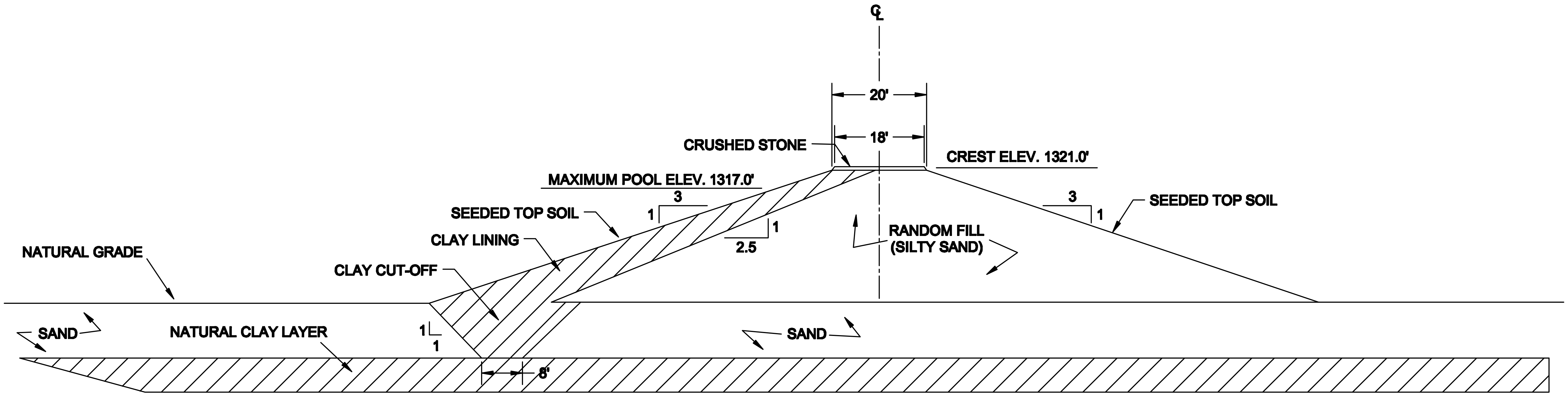


UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: ATJ DWN BY: MS	ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. No.: A Date: 6-14-2010
AMEC Earth & Environmental 690 Commonwealth Business Center 11003 Bluegrass Parkway Louisville, KY 40299	Datum: NAD 83 Projection: Albers Scale: As Shown	MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN WETLAND INVENTORY	Project No: 3-2106-0174-0300 Figure No: 4

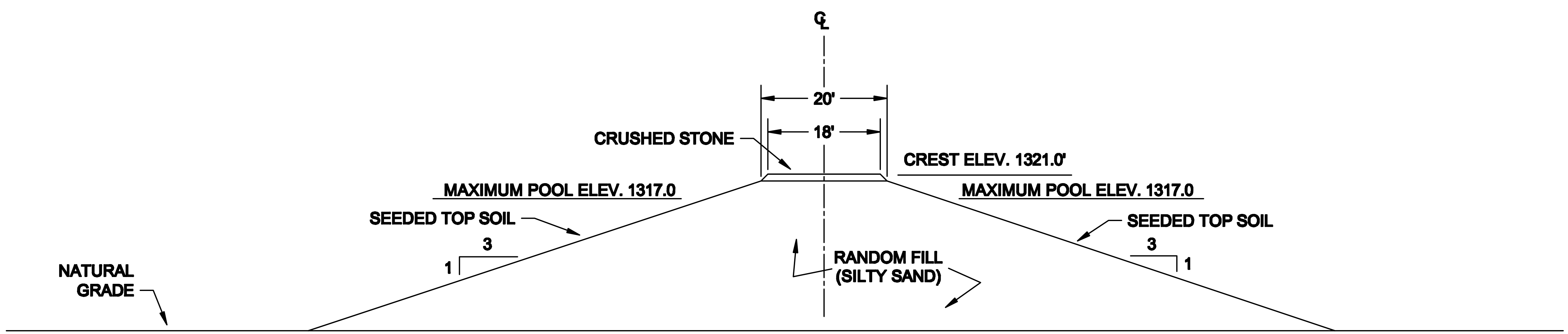


SOURCE: GROUNDWATER ELEVATION SUMMARY 2006-2010

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/10/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. MONITORING WELL LOCATIONS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE: AS SHOWN	FIGURE No. 5



TYPICAL SECTION - PERIMETER DIKE



TYPICAL SECTION - INTERIOR DIKE

SOURCE: EBASCO SERVICES MINNESOTA POWER AND LIGHT COMPANY, CLAY BOSWELL STEAM ELECTRIC STATION, UNIT NO. 4 ASH DISPOSAL POND, DIKE AND FOUNDATION STUDIES, ENGINEERING REPORT NOVEMBER 1997

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

CLIENT LOGO

CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

amec

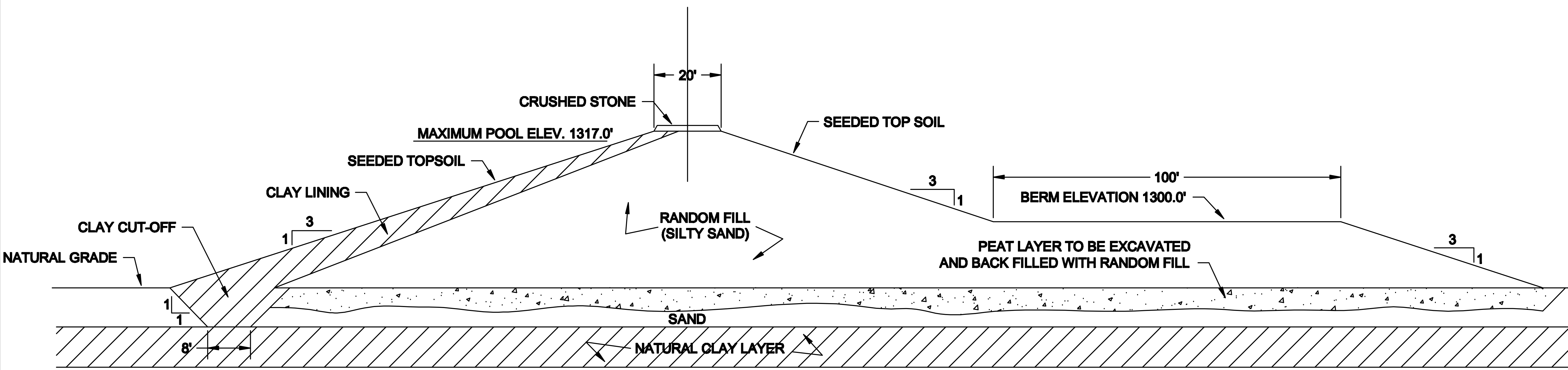
DWN BY:	CAE
CHK'D BY:	MGS
DATUM:	
PROJECTION:	
SCALE:	NOT TO SCALE

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
TYPICAL CROSS-SECTION
ACTIVE ASH POND COMPLEX

DATE:	6/11/10
PROJECT NO:	3-2106-0174.0300
REV. NO.:	
FIGURE No.	6

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\March 2010 RFP Pro\Allete\Plant Boswell\Figures\fig6bos—cstypashpond.dwg — Layout1 — Jun. 15, 2010 9:51am — chris.eger



MAXIMUM HEIGHT PERIMETER DIKE CROSS-SECTION

SOURCE: EBASCO SERVICES MINNESOTA POWER AND LIGHT COMPANY, CLAY BOSWELL STEAM ELECTRIC STATION, UNIT NO. 4 ASH DISPOSAL POND, DIKE AND FOUNDATION STUDIES, ENGINEERING REPORT NOVEMBER 1997

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

CLIENT LOGO

CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

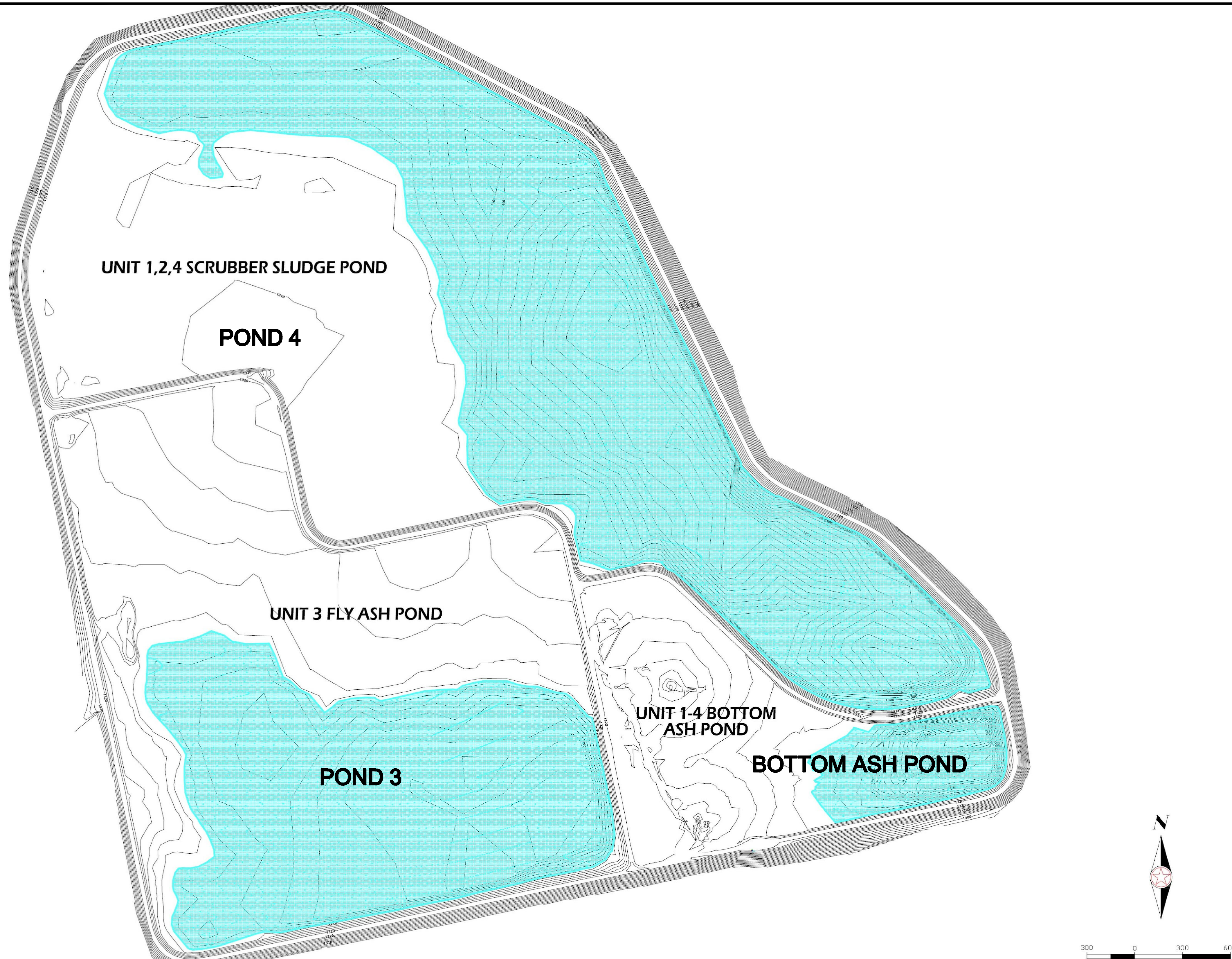
DWN BY:	CAE
CHK'D BY:	MGS
DATUM:	
PROJECTION:	
SCALE:	NOT TO SCALE

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
MAXIMUM HEIGHT CROSS-SECTION
ACTIVE ASH POND COMPLEX

DATE:	6/11/10
PROJECT NO:	3-2106-0174.0300
REV. NO.:	
FIGURE No.	7

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\March 2010 RFP Pro\Allete\Plant Boswell\Figures\fig7bos—csmaxashpond.dwg — Layout1 — Jun. 15, 2010 9:55am — chris.eger



SOURCE: MINNESOTA POWER, BOSWELL ENERGY CENTER ASH POND EXISITING CONTOURS, JANUARY 11, 2006

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

CLIENT LOGO

CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

amec

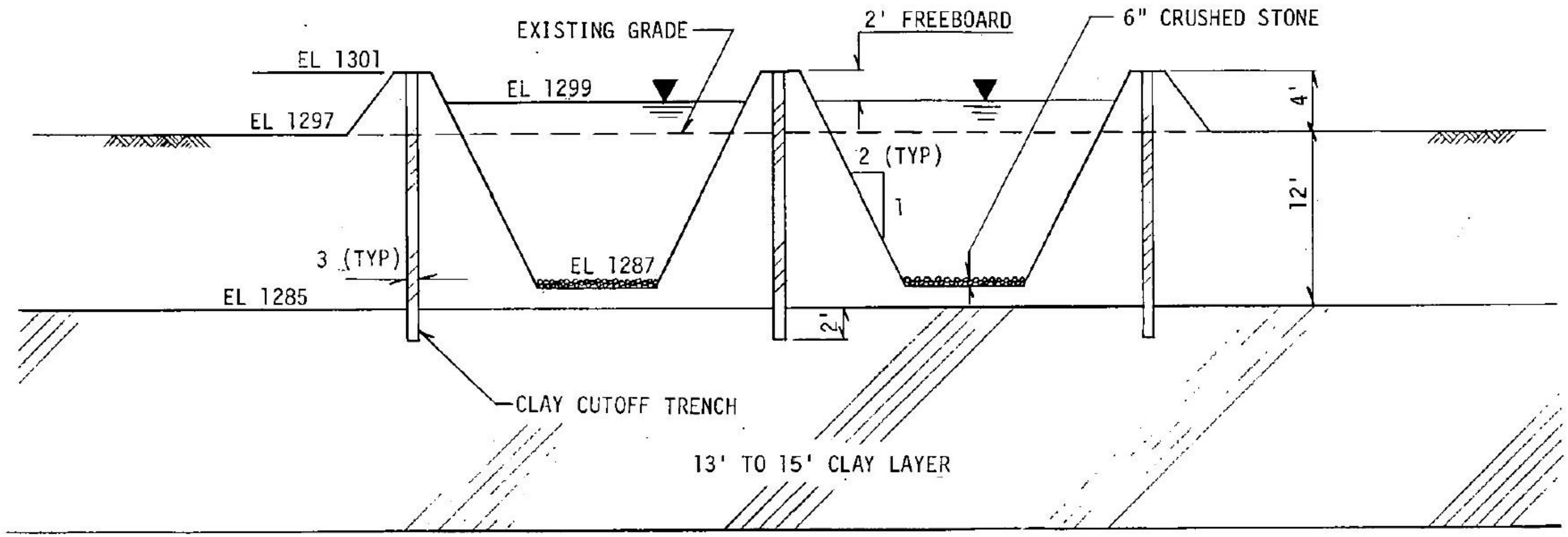
DWN BY:	CAE
CHK'D BY:	MGS
DATUM:	
PROJECTION:	
SCALE:	AS SHOWN

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN.
ACTIVE ASH POND COMPLEX PLAN VIEW AND 2006
TOPOGRAPHIC SURVEY

DATE:	6/10/10
PROJECT NO:	3-2106-0174.0300
REV. NO.:	
FIGURE No.	8

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\March 2010 RFP Pro\Allete\Plant Boswell\Figures and Appendix\GIS and CAD\fig8bos-toposurvey.dwg - Layout1 - Jun. 17, 2010 2:06pm - chris.eger



SECTION A

SOURCE: EBASCO SERVICES, MINNESOTA POWER AND LIGHT COMPANY, CLAY BOSWELL STEAM ELECTRIC STATION, UNIT NO. 4 WASTEWATER HOLDING BASINS SEEPAGE STUDY, DECEMBER, 1977

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

CLIENT LOGO

CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

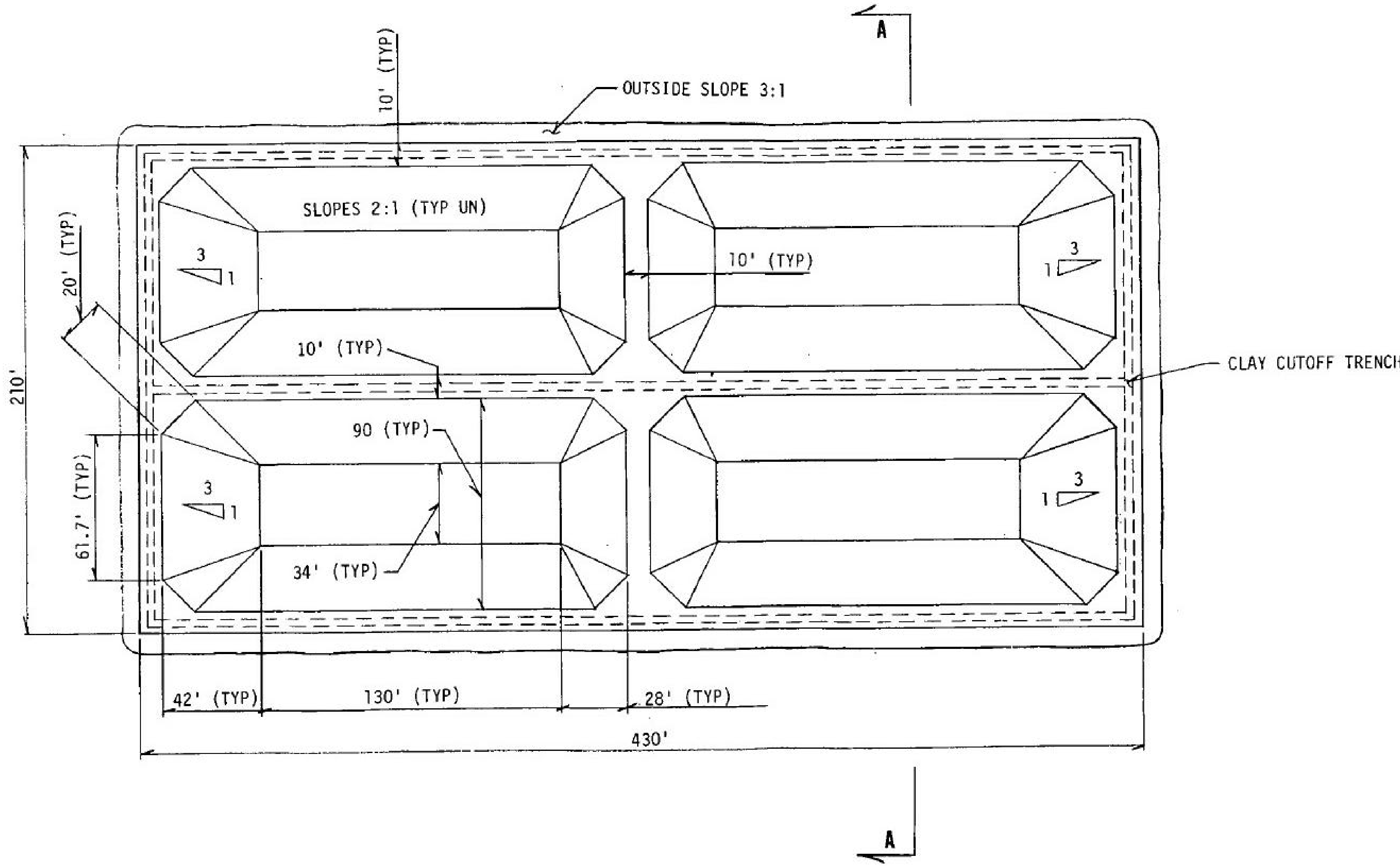
DWN BY:	CAE
CHK'D BY:	MGS
DATUM:	
PROJECTION:	
SCALE:	NOT TO SCALE

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
WASTE WATER TREATMENT PLANT BASINS
TYPICAL CROSS SECTION

DATE:	6/11/10
PROJECT NO:	3-2106-0174.0300
REV. NO.:	
FIGURE No.	9

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\March 2010 RFP Pro\Allete\Plant Boswell\Figures and Appendix\GIS and CAD\fig9bos–wastewatercross.dwg – Layout1 – Jun. 17, 2010 2:12pm – chris.eger



SOURCE: EBASCO SERVICES, MINNESOTA POWER AND LIGHT COMPANY, CLAY BOSWELL STEAM ELECTRIC STATION, UNIT NO. 4 WASTEWATER HOLDING BASINS SEEPAGE STUDY, DECEMBER, 1977

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT	CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DATE: 6/11/10 PROJECT NO: 3-2106-0174.0300
		AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN WASTE WATER TREATMENT PLANT BASINS PLAN VIEW	REV. NO.: FIGURE No. 10

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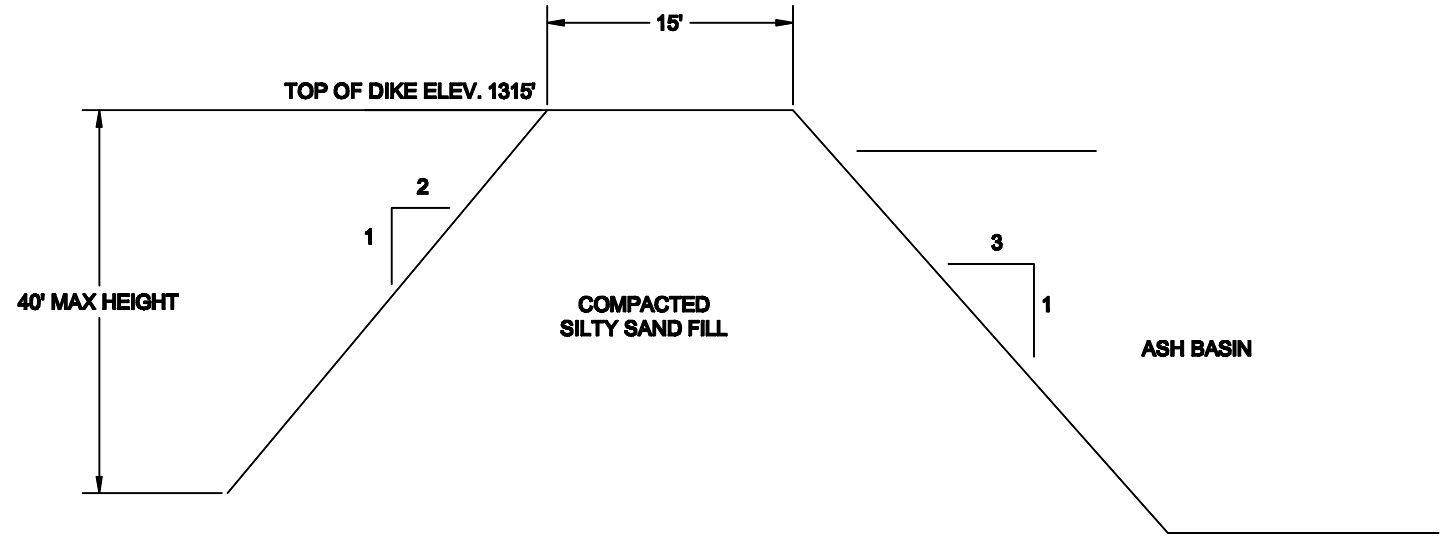
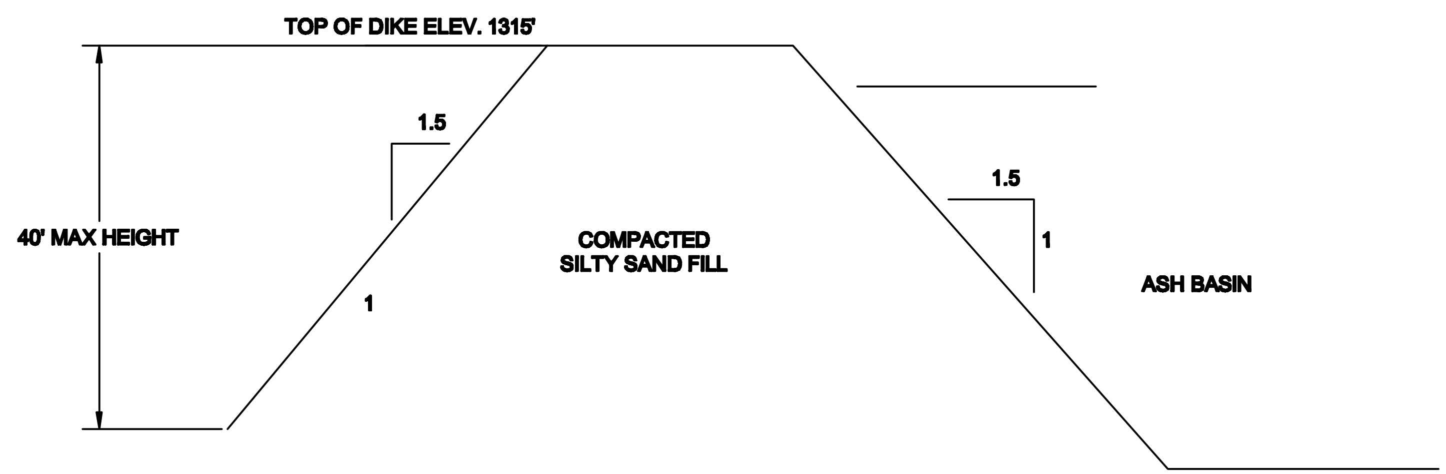


TYPICAL SECTION PERIMETER DIKE



TYPICAL SECTION DIVIDING DIKE (WESTERN DIKE)

NOTE: SECTION IIIB OF EBASCO'S AUGUST 1981 REPORT STATED " *DURING INITIAL FILLING OF THE BOTTOM ASH POND, SOME INSTABILITY OF THE DIVIDING DIKE WAS NOTED AND A DOWNSTREAM BERM WAS CONSTRUCTED TO INCREASE THE EFFECTIVE SLOPE, THEREBY INCREASING THE STABILITY OF THE EMBANKMENT. RIP-RAP WAS USED TO INCREASE STABILITY OF THE UPSTREAM SLOPE* ". NO OTHER DETAILS OR DRAWINGS WERE PROVIDED REGARDING THIS MODIFICATION

SOURCE: EBASCO SERVICES MINNESOTA POWER CLAY BOSWELL STEAM ELECTRIC STATION, POND CLOSURE AND SEALING PLAN UNIT #3 FLY AND BOTTOM ASH PONDS, AUGUST 1981

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT	CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DATE: 6/11/10 PROJECT NO: 3-2106-0174.0300
		AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	DATUM: PROJECTION: SCALE: NOT TO SCALE	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN TYPICAL DIKE CROSS-SECTION INACTIVE BOTTOM ASH POND	REV. NO.: FIGURE No. 11

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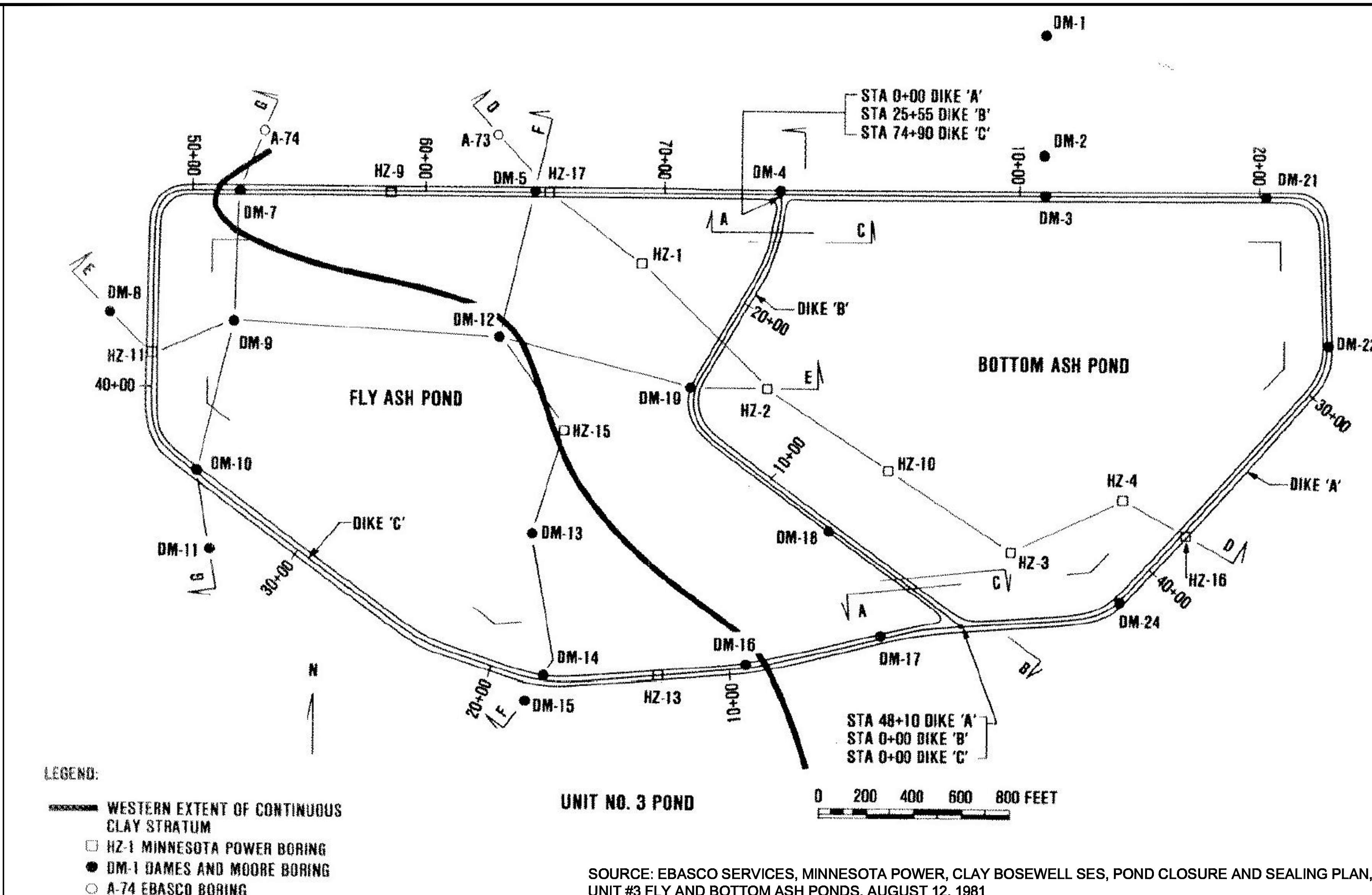


SOURCE: EBASCO SERVICES, MINNESOTA POWER, CLAY BOSEWELL SES, POND CLOSURE AND SEALING PLAN, UNIT #3 FLY AND BOTTOM ASH PONDS, AUGUST 12, 1981

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN INACTIVE BOTTOM ASH POND PLAN VIEW	PROJECT NO: 3-2106-0174.0300 FIGURE No. 12

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\March 2010 RFP Pro\Allete\Plant Boswell\Figures and Appendix\GIS and CAD\fig12bos-inactivebottomplanview.dwg - Layout1 - Jun. 17, 2010 2:27pm - chris.eger

APPENDIX A
Waste Impoundment Inspection Forms

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name: Minnesota Power- Plant Boswell Date: 5/18/10

Unit Name: Complex – Pond 3, 4, and Bottom Ash Operator's Name:Minnesota Power

Unit I.D.: As Above Hazard Potential Classification: High **Significant** Low

Inspector's Name: Dave Ott, P.E., Mary Swiderski

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Daily		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	1305-1308		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	N/A		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		N/A
5. Lowest dam crest elevation (operator records)?	1321		Is water exiting outlet, but not entering inlet?		N/A
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?		N/A
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?		N/A	From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)	X		At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?		N/A	From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		N/A
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		N/A
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
3, 4, 12, 20, 21	No Decant Inlet, material is pumped to pond/river/plant.
9	One tree approximately 3 inch diameter. Cut down, but still alive
6	Instrumentation includes monitoring wells.
21, 23	Unit is located in/adjacent to wetlands.

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # MN 0001007
Date 5/18/10

INSPECTOR David Ott, P.E. Mary Swiderski

Impoundment Name Plant Boswell – Complex: Pond 3, 4, and Bottom Ash Pond
Impoundment Company Minnesota Power
EPA Region 5
State Agency (Field Office) Address Minnesota Department of Natural Resources
520 West Lafayette Blvd.
St, Paul, MN 55155

Name of Impoundment Complex: Pond 3, 4, and Bottom Ash Pond
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New X Update ______

	Yes	No
Is impoundment currently under construction?		X
Is water or ccw currently being pumped into the impoundment?	X	

IMPOUNDMENT FUNCTION: Pond 3: FGD Sludge, Unit 1, 2, 3 scrubber solids. Pond 4: Fly Ash Scrubber Solids from Unit 4. Bottom Ash Pond: Receives Bottom Ash

Nearest Downstream Town : Name Cohasset, MN
Distance from the impoundment N/A or 0 miles
Impoundment
Location: Longitude -93 Degrees 4 Minutes 4 Seconds
Latitude 47 Degrees 16 Minutes 11 Seconds
State MN County Itasca

Does a state agency regulate this impoundment? YES X NO ______

If So Which State Agency? MPCA (water quality), MDNR (Dam Safety)

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______**LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______**LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

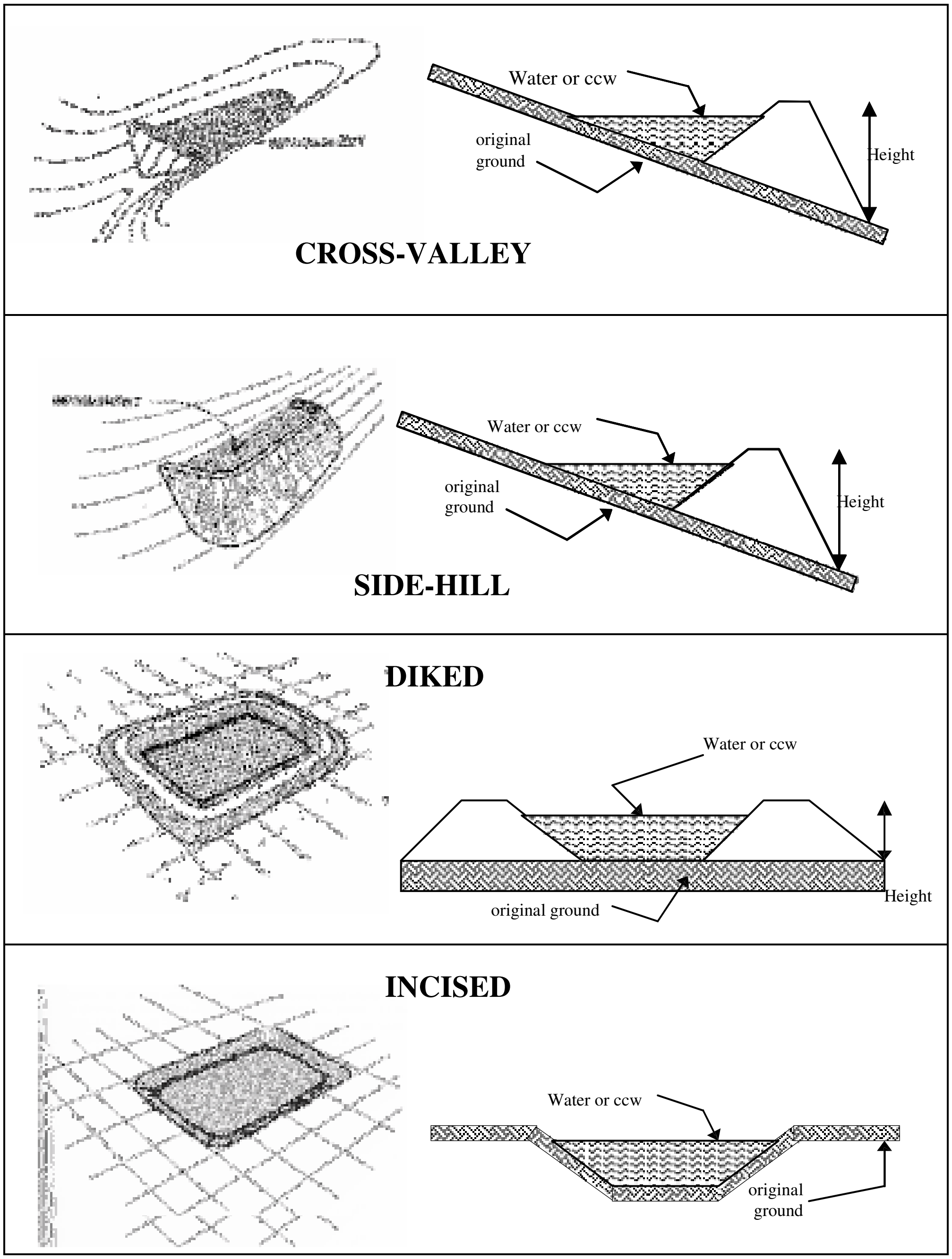
X______**SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______**HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

- Pond located within developed areas,
- State Agency classifies impoundment as significant hazard, and
- Failure will not likely cause loss of human life.

CONFIGURATION:



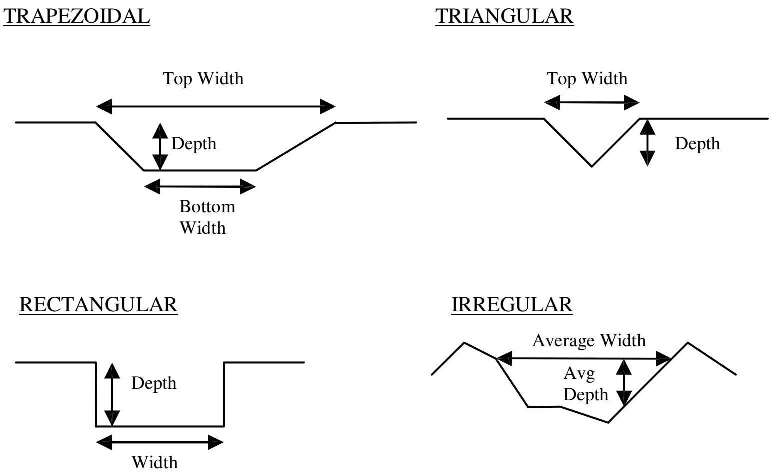
______Cross-Valley
______Side-Hill
__X___Diked
______Incised (form completion optional)
______Combination Incised/Diked

Embankment Height __7-45'______feet Embankment Material_Typical Fill_______
Pool Area __approx 645_________ acres Liner _Clay_________________________
Current Freeboard _12.5'_________ feet Liner Permeability _7.7 x10^{-6} to 7.4x10^{-9}_

TYPE OF OUTLET (Mark all that apply)

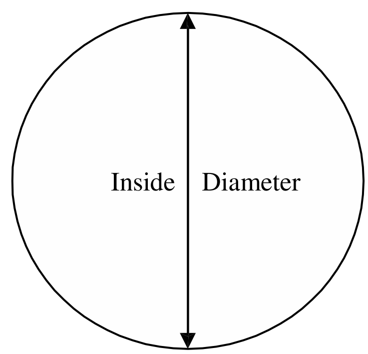
N/A Open Channel Spillway
______Trapezoidal
______Triangular
______Rectangular
______Irregular

______depth
______bottom (or average) width
______top width



N/A Outlet

______inside diameter



Material
______corrugated metal
______welded steel
______concrete
______plastic (hdpe, pvc, etc.)
______other (specify) ______________________

Is water flowing through the outlet? YES _______ NO _______

______No Outlet

X Other Type of Outlet (specify) Pumped to Plant/River/Ponds

Pond 3 → 3.9” ID HDPE, Pond 4 → 9.3” ID HDPE, Bottom Ash Pond → 13.1” Carbon Steel

The Impoundment was Designed By Ebasco

Has there ever been a failure at this site? YES ___________NO ____X_______

If So When? _____________________________

If So Please Describe : ____

Has there ever been significant seepages at this site? YES ________NO ___X___

If So When? ____________________________

IF So Please Describe: ____

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________NO ___X___

If so, which method (e.g., piezometers, gw pumping,...)? ______________________

If so Please Describe : ____

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Minnesota Power- Plant Boswell	Date: 5/18/10
Unit Name: Wastewater Treatment Plant Ponds	Operator's Name: Minnesota Power
Unit I.D.: As Above	Hazard Potential Classification: High **Significant** Low
Inspector's Name: Dave Ott, P.E., Mary Swiderski	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Every 2 hrs		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	1294		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	N/A		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		N/A
5. Lowest dam crest elevation (operator records)?	1301		Is water exiting outlet, but not entering inlet?		N/A
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?		N/A
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?		N/A	From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?		N/A	From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		N/A
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
3, 4, 12, 20, 21	No Decant Outlet, water is pumped to WWTP

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # MN 0001007
Date 5/18/10

INSPECTOR David Ott, P.E. Mary Swiderski

Impoundment Name Wastewater Treatment Plant Ponds
Impoundment Company Minnesota Power
EPA Region 5
State Agency (Field Office) Address Minnesota Department of Natural Resources
520 West Lafayette Blvd.
St, Paul, MN 55155

Name of Impoundment Wastewater Treatment Plan Ponds
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New X Update ____

	Yes	No
Is impoundment currently under construction?		X
Is water or ccw currently being pumped into the impoundment?	X	

IMPOUNDMENT FUNCTION: Sedimentation Treatment from bottom ash pond and power plant prior to WWTP

Nearest Downstream Town : Name Cohasset, MN
Distance from the impoundment N/A or 0 miles
Impoundment
Location: Longitude -93 Degrees 38 Minutes 59 Seconds
Latitude 47 Degrees 15 Minutes 34 Seconds
State MN County Itasca

Does a state agency regulate this impoundment? YES X NO ____

If So Which State Agency? MPCA, MDNR (Dam Safety)

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______**LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______**LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

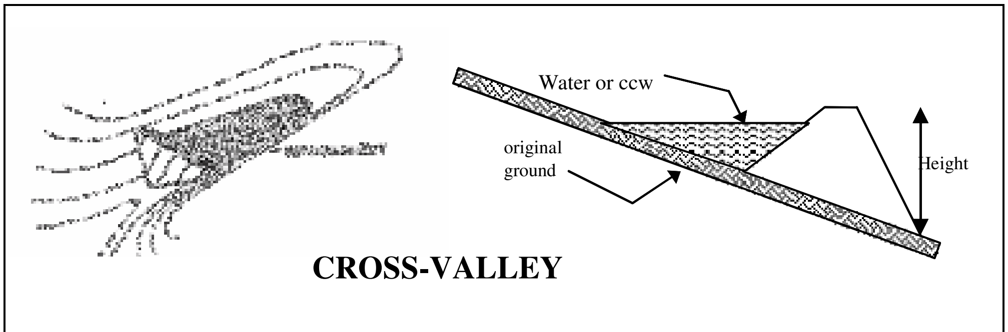
__X____**SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

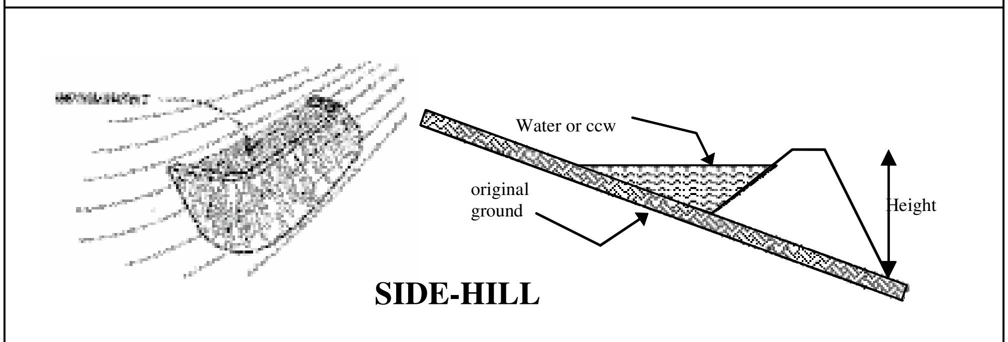
______**HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

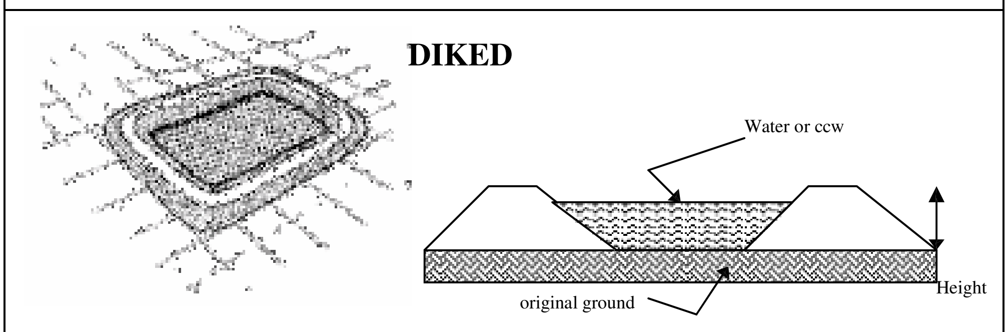
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

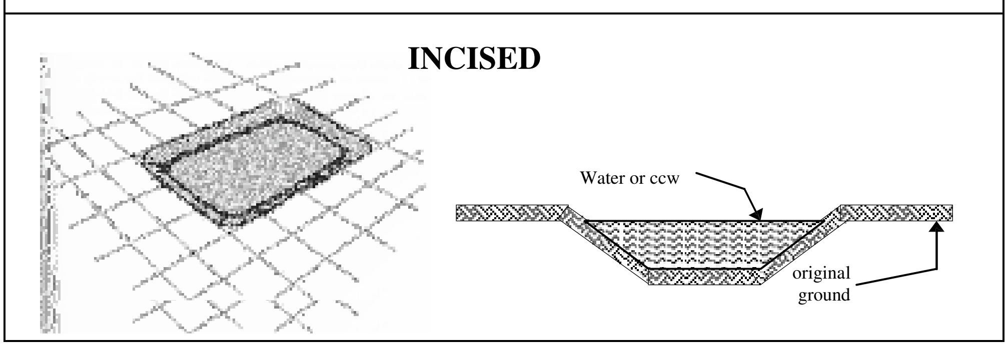
- Due to ponds close proximity to the Mississippi River, failure would most likely cause contamination that would not principally be limited to the owner's property.

CONFIGURATION:









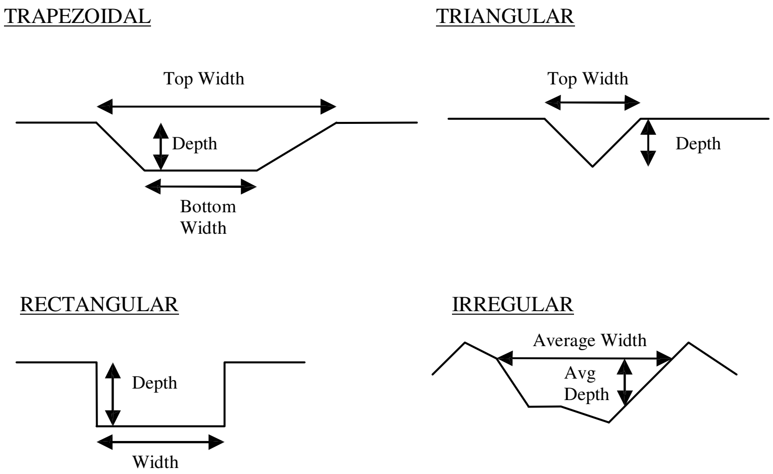
______Cross-Valley
______Side-Hill
______Diked
______Incised (form completion optional)
__X__Combination Incised/Diked

Embankment Height __4________feet Embankment Material Silty Sand________
Pool Area __1.6________________ acres Liner _Clay
Current Freeboard _6__________ feet Liner Permeability __________________

TYPE OF OUTLET (Mark all that apply)

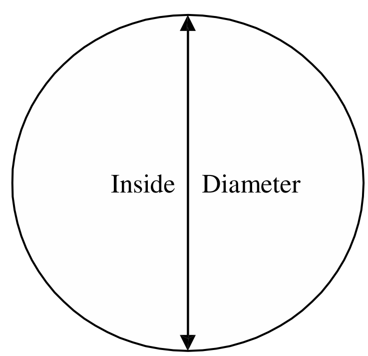
N/A Open Channel Spillway
______Trapezoidal
______Triangular
______Rectangular
______Irregular

______depth
______bottom (or average) width
_____top width



N/A Outlet

______inside diameter



Material
______corrugated metal
______welded steel
______concrete
______plastic (hdpe, pvc, etc.)
______other (specify) ______________________

Is water flowing through the outlet? YES _______ NO _______

______No Outlet

X Other Type of Outlet (specify) Pumped to WWTP

Pipe → 23.25 inch Carbon Steel

The Impoundment was designed By Ebasco

Has there ever been a failure at this site? YES ___________NO ____X_______

If So When? ______________________________

If So Please Describe : ____

Has there ever been significant seepages at this site? YES ________NO ___X___

If So When? ____________________________

IF So Please Describe: ____________________________

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________NO ___X___

If so, which method (e.g., piezometers, gw pumping,...)? ______________________

If so Please Describe : ____

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Minnesota Power- Plant Boswell	Date: 5/18/10
Unit Name: Inactive Bottom Ash Pond	Operator's Name: Minnesota Power
Unit I.D.: As Above	Hazard Potential Classification: High **Significant** Low
Inspector's Name: Dave Ott, P.E., Mary Swiderski	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Monthly		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	1292.8		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	N/A		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		N/A
5. Lowest dam crest elevation (operator records)?	1315		Is water exiting outlet, but not entering inlet?		N/A
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?		N/A
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?		N/A	From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?		N/A	From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		N/A
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
3, 4, 12, 20, 21	No outlet or inlet. Pond accepts rainfall, loses water thru evaporation and/or seepage

General Note: Steep Slope along interior dike

EPA FORM -XXXX

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # MN 0001007

INSPECTOR David Ott, P.E. Mary Swiderski

Date 5/18/10

Impoundment Name Inactive Bottom Ash Pond
Impoundment Company Minnesota Power
EPA Region 5
State Agency (Field Office) Address Minnesota Department of Natural Resources
520 West Lafayette Blvd.
St, Paul, MN 55155

Name of Impoundment Inactive Bottom Ash Pond
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New X Update ____

	Yes	No
Is impoundment currently under construction?		X
Is water or ccw currently being pumped into the impoundment?		X

IMPOUNDMENT FUNCTION: Formerly used for fly and bottom ash disposal

Nearest Downstream Town : Name Cohasset, MN
Distance from the impoundment N/A or 0 miles
Impoundment
Location: Longitude -93 Degrees 40 Minutes 15 Seconds
Latitude 47 Degrees 15 Minutes 49 Seconds
State MN County Itasca

Does a state agency regulate this impoundment? YES X NO ____

If So Which State Agency? MPCA, MDNR (Dam Safety) Permit 56-197

<u>**HAZARD POTENTIAL**</u> (In the event the impoundment should fail, the following would occur):

______**LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______**LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

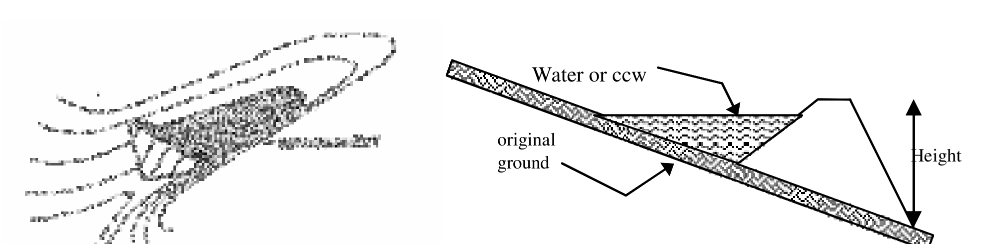
__**X**____**SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______**HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

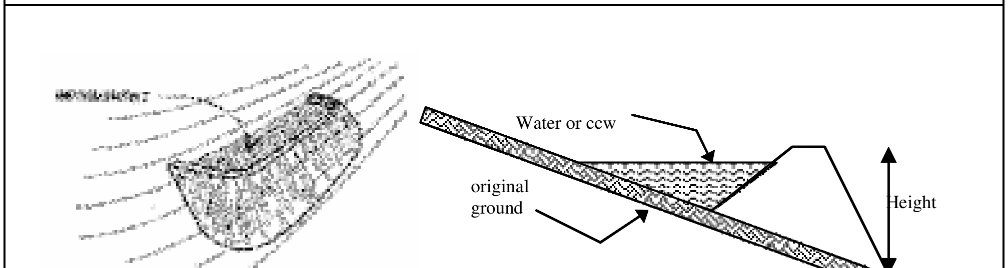
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

- Damage could result in release to Mississippi River,
- CCW material in pond is covered and has been actively drained for years.
- No probable loss of human life, and
- Economic and/or environmental losses are expected to be low.

CONFIGURATION:

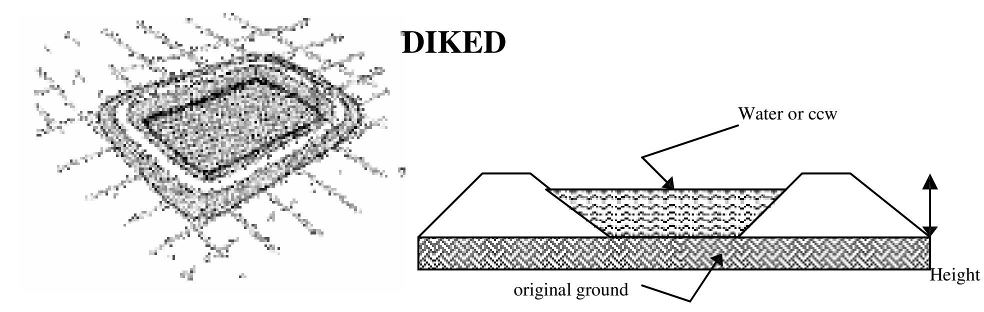


CROSS-VALLEY

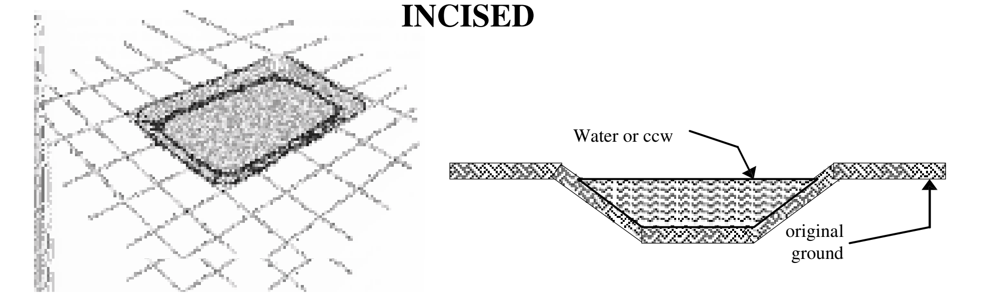


SIDE-HILL

DIKED



INCISED



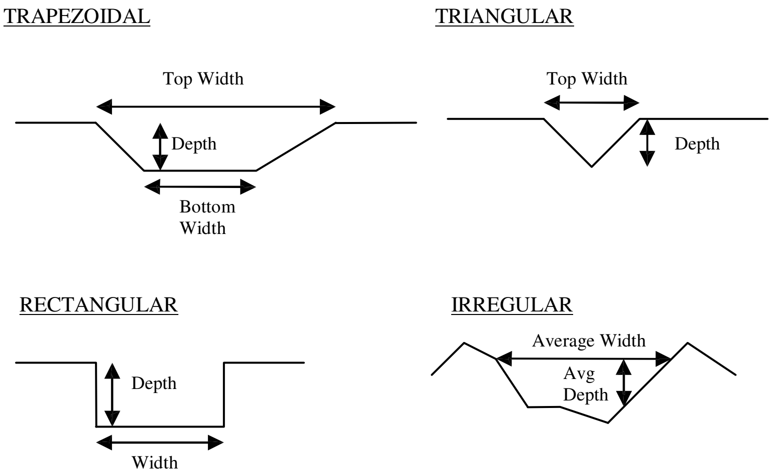
______Cross-Valley
______Side-Hill
__**X**__Diked
______Incised (form completion optional)
______Combination Incised/Diked

Embankment Height 26.7 feet Embankment Material Silty Sands
Pool Area 200 acres Liner: Soil/bentonite slurry/ natural clay
Current Freeboard 22.2 feet Liner Permeability __________

TYPE OF OUTLET (Mark all that apply)

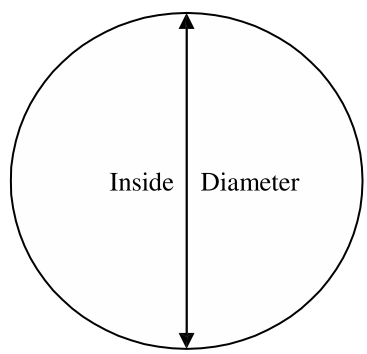
_N/A__Open Channel Spillway
______Trapezoidal
______Triangular
______Rectangular
______Irregular

______depth
______bottom (or average) width
______top width



_N/A__Outlet

______inside diameter



Material
______corrugated metal
______welded steel
______concrete
______plastic (hdpe, pvc, etc.)
______other (specify) _______________________

Is water flowing through the outlet? YES ________ NO ________

_X___No Outlet

______Other Type of Outlet (specify) ____________________________________

The Impoundment was Designed By unknown____________________________________

Has there ever been a failure at this site? YES ___________ NO ____X_______

If So When? ____________________________

If So Please Describe : ____

Has there ever been significant seepages at this site? YES ________NO ___X___

If So When? ____________________________

IF So Please Describe: ____

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________NO ___X___

If so, which method (e.g., piezometers, gw pumping,...)? ____________________

If so Please Describe : ____

APPENDIX B
Site Photo Log Map and Site Photos

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		DWN BY: ATJ	ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. No.: A
		DWN BY: MS		Date: 6-14-2010
AMEC Earth & Environmental 690 Commonwealth Business Center 11003 Bluegrass Parkway Louisville, KY 40299	amec	Datum: NAD 83	MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX PHOTO LOCATION MAP	Project No: 3-2106-0174-0300
		Projection: Albers		
		Scale: As Shown		Figure No: B-1

	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: ATJ	ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. No.: A
		DWN BY: MS		Date: 6-14-2010
AMEC Earth & Environmental 690 Commonwealth Business Center 11003 Bluegrass Parkway Louisville, KY 40299	amec	Datum: NAD 83	MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN WASTE WATER TREATMENT PLANT PHOTO LOCATION MAP	Project No: 3-2106-0174-0300
		Projection: Albers		
		Scale: As Shown		Figure No: B-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: ATJ	ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. No.: A
	DWN BY: MS		Date: 6-14-2010
AMEC Earth & Environmental 690 Commonwealth Business Center 11003 Bluegrass Parkway Louisville, KY 40299	Datum: NAD 83	MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN INACTIVE BOTTOM ASH POND PHOTO LOCATION MAP	Project No: 3-2106-0174-0300
	Projection: Albers		Figure No: B-3
	Scale: As Shown		

ACTIVE ASH POND COMPLEX
SITE PHOTOS

1-1
FROM CREST OF SOUTHEAST DIKE LOOKING WEST TOWARDS BOTTOM ASH POND

1-2
FROM CREST OF SOUTHEAST DIKE LOOKING NORTH TOWARDS BOTTOM ASH POND

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT	UNITED STATES EMVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-4

1-3

FROM CREST OF SOUTHEAST DIKE LOOKING NORTHEAST TOWARDS BOTTOM ASH POND

1-4

FROM OLD ROUTE 6 ALONG SOUTHEAST DIKE LOOKING WEST

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-5

1-5

FROM TOE OF SOUTHEAST DIKE LOOKING WEST

1-6

MONITORING WELLS NA186S AND NA186D

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700		CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-6

1-7

WETLAND AREA ALONG SOUTHERN DOWNSTREAM TOE

1-8

INACTIVE INTAKE STRUCTURE

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-7

1-9

WETLAND AREA ALONG SOUTHERN DOWNSTREAM TOE

1-10

CLEARED AREA ALONG WESTERN DOWNSTREAM TOE

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-8

1-11
LOW AREA ALONG WESTERN DOWNSTREAM TOE

1-12
WET AREA ALONG WESTERN DOWNSTREAM TOE

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES EMVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-9

1-13

VIEW FROM WESTERN DIKE LOOKING NORTHEAST TOWARDS POND 4

1-14

TREE WITHIN SOUTHERN EMBANKMENT DOWNSTREAM SLOPE

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690 Commonwealth Center
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Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES EMVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-10

1-15

SWALE ALONG SOUTHERN DOWNSTREAM SLOPE

1-16

WETLAND AREA ALONG NORTHWESTERN DOWNSTREAM TOE

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-11

1-17

CLEARED AREA ALONG NORTHEASTERN DOWNSTREAM TOE

1-18

LOW AREA ALONG EASTERN DOWNSTREAM TOE

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-12

1-19

GENERAL SITE PHOTO FROM EASTERN DOWNSTREAM TOE LOOKING NORTH

1-20

FROM EASTERN DOWNSTREAM TOE LOOKING SOUTHEAST TOWARDS BOSWELL ENERGY CENTER

AMEC Earth & Environmental

690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES EMVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-13

1-21
DISCHARGE LINES FROM PUMP HOUSE ALONG SOUTHEASTERN TOE

1-22
EROSION CONTROL EFFORTS ALONG SOUTHEASTERN DOWNSTREAM TOE

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690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES EMVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-14

1-23

GENERAL SITE PHOTO ALONG SOUTHEASTERN DOWNSTREAM TOE

1-24

VIEW FROM SOUTHERN DIKE ALONG BOTTOM ASH POND LOOKING EAST TOWARDS BOTTOM ASH POND

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-15

1-25

INTAKE STRUCTURE FOR BOTTOM ASH POND DISCHARGE LINES

1-26

VIEW FROM SOUTHERN DIKE ALONG BOTTOM ASH POND LOOKING NORTH

AMEC Earth & Environmental

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Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO

CLIENT
UNITED STATES EMVIRONMENTAL PROTECTION AGENCY

PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-16

1-27
MAINTENANCE STRUCTURE IN BOTTOM ASH POND, DISCHARGE LINES IN FOREGROUND

1-28
OUTLET STRUCTURE FROM POND 3

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-17

1-29

VIEW FROM DIVIDING DIKE BETWEEN BOTTOM ASH POND AND POND 3 LOOKING NORTH

1-30

VIEW FROM DIVIDING DIKE AT INTERSECTION OF BOTTOM ASH POND, POND 3 AND POND 4 LOOKING WEST

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-18

1-31

VIEW FROM DIVIDING DIKE AT INTERSECTION OF BOTTOM ASH POND, POND 3 AND POND 4 LOOKING NORTH

1-32

VIEW FROM DIVIDING DIKE BETWEEN POND 3 AND POND 4 LOOKING SOUTH

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690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO

CLIENT: UNITED STATES EMVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-19

1-33

DISCHARGE STRUCTURE FROM PLANT TO POND 4

1-34

VIEW FROM NORTHERN DIKE LOOKING TOWARDS BOSWELL ENERGY CENTER
ILLUSTRATES REPAIRED DIKE ALONG POND 4

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES EMVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	APPENDIX: B-20

1-35

VIEW FROM NORTHERN UPSTREAM DIKE ALONG POND 4 LOOKING EAST - ILLUSTRATES PREVIOUS DIKE EROSION REPAIRS AND WAVE ACTION

1-36

VIEW FROM NORTHERN UPSTREAM DIKE ALONG POND 4 LOOKING WEST - ILLUSTRATES PREVIOUS DIKE EROSION REPAIRS AND WAVE ACTION

AMEC Earth & Environmental

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11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES EMVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-21

1-37

OUTLET STRUCTURE FOR POND 4

1-38

OUTLET STRUCTURE FOR POND 4

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO

CLIENT: UNITED STATES EMVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
ACTIVE ASH POND COMPLEX SITE PHOTOS

DWN BY: CAE	DATUM:	DATE: 6/11/10
CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
PROJECTION:	SCALE:	APPENDIX: B-22

1-39

OUTLET STRUCTURE FOR BOTTOM ASH POND

1-40

OUTLET DRAIN FOR PUMP HOUSE ALONG SOUTHEASTERN DOWNSTREAM TOE

AMEC Earth & Environmental

690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO

CLIENT
UNITED STATES
EMVIRONMENTAL
PROTECTION AGENCY

PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/11/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN ACTIVE ASH POND COMPLEX SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	APPENDIX: B-23

WASTE WATER TREATMENT PLANT
SITE PHOTOS

2-1

GENERAL SITE PHOTO FROM CENTER OF POND LOOKING WEST

2-2

GENERAL SITE PHOTO FROM CENTER OF POND LOOKING EAST

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. WASTE WATER TREATMENT PLANT SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-24

2-3
VIEW ALONG OUTFALL (SD004) LOOKING EAST

2-4
GENERAL SITE PHOTO FROM CENTER OF POND LOOKING EAST

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CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. WASTE WATER TREATMENT PLANT SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-25

2-5

FROM NORTHEASTERN EDGE OF WWTP LOOKING WEST TOWARDS PLANT

2-6

FROM NORTHEATERN EDGE OF WWTP LOOKING EAST

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690 Commonwealth Center
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Louisville, Ky 40299
(502) 267-0700

amec

CLIENT LOGO

CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN.
WASTE WATER TREATMENT PLANT SITE PHOTOS

DWN BY: CAE	DATUM:		DATE: 6/13/10
CHK'D BY: MGS	REV. NO.:		PROJECT NO: 3-2106-0174.0300
PROJECTION:	SCALE:		PAGE NO. B-26

INACTIVE BOTTOM ASH POND
SITE PHOTOS

3-1
GENERAL SITE PHOTO FROM NORTHERN DIKE LOOKING WEST

3-2
GENERAL SITE PHOTO FROM NORTHERN DIKE LOOKING NORTHWEST

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. INACTIVE BOTTOM ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-27

3-3

GENERAL SITE PHOTO FROM NORTHERN DIKE LOOKING NORTH

3-4

GENERAL SITE PHOTO FROM NORTHERN DIKE LOOKING EAST TOWARDS THE CLOSED HIBBING PUBLIC UTILITIES ASH CELL

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. INACTIVE BOTTOM ASH POND SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	SCALE:	PAGE NO. B-28

3-5

GENERAL DOWNSTREAM SLOPE ALONG EASTERN DIKE

3-6

VIEW FROM EASTERN DIKE LOOKING SOUTHWEST TOWARDS INDUSTRIAL SOLID WASTE AREA AND INACTIVE BOTTOM ASH POND

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Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. INACTIVE BOTTOM ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-29

3-7

OLD DISCHARGE STRUCTURE ALONG SOUTHEASTERN DOWNSTREAM TOE

3-8

GAUGE IN INACTIVE BOTTOM ASH POND ALONG SOUTHEASTERN UPSTREAM TOE AT APPROX 1292 FEET

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PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. INACTIVE BOTTOM ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-30

3-9

GENERAL SITE PHOTO ALONG SOUTHERN DOWNSTREAM TOE LOOKING WEST (NEAR MONITORING WELLS NDM24S/24D)

3-10

GENERAL SITE PHOTO ALONG SOUTHERN DOWNSTREAM TOE LOOKING EAST

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Louisville, Ky 40299
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CLIENT LOGO

CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. INACTIVE BOTTOM ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-31

3-11

VIEW FROM SOUTHERN DIKE LOOKING WEST TOWARDS INACTIVE FLY ASH POND

3-12

VIEW FROM SOUTHERN DIKE LOOKING NORTH TOWARDS INACTIVE FLY ASH POND AND DIVIDING DIKE

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PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. INACTIVE BOTTOM ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-32

3-13

TYPICAL DOWNSTREAM SLOPE FROM WESTERN (DIVIDING) DIKE LOOKING NORTH

3-14

VIEW FROM WESTERN DIKE LOOKING NORTHEAST (NOTE STEEP SLOPES)

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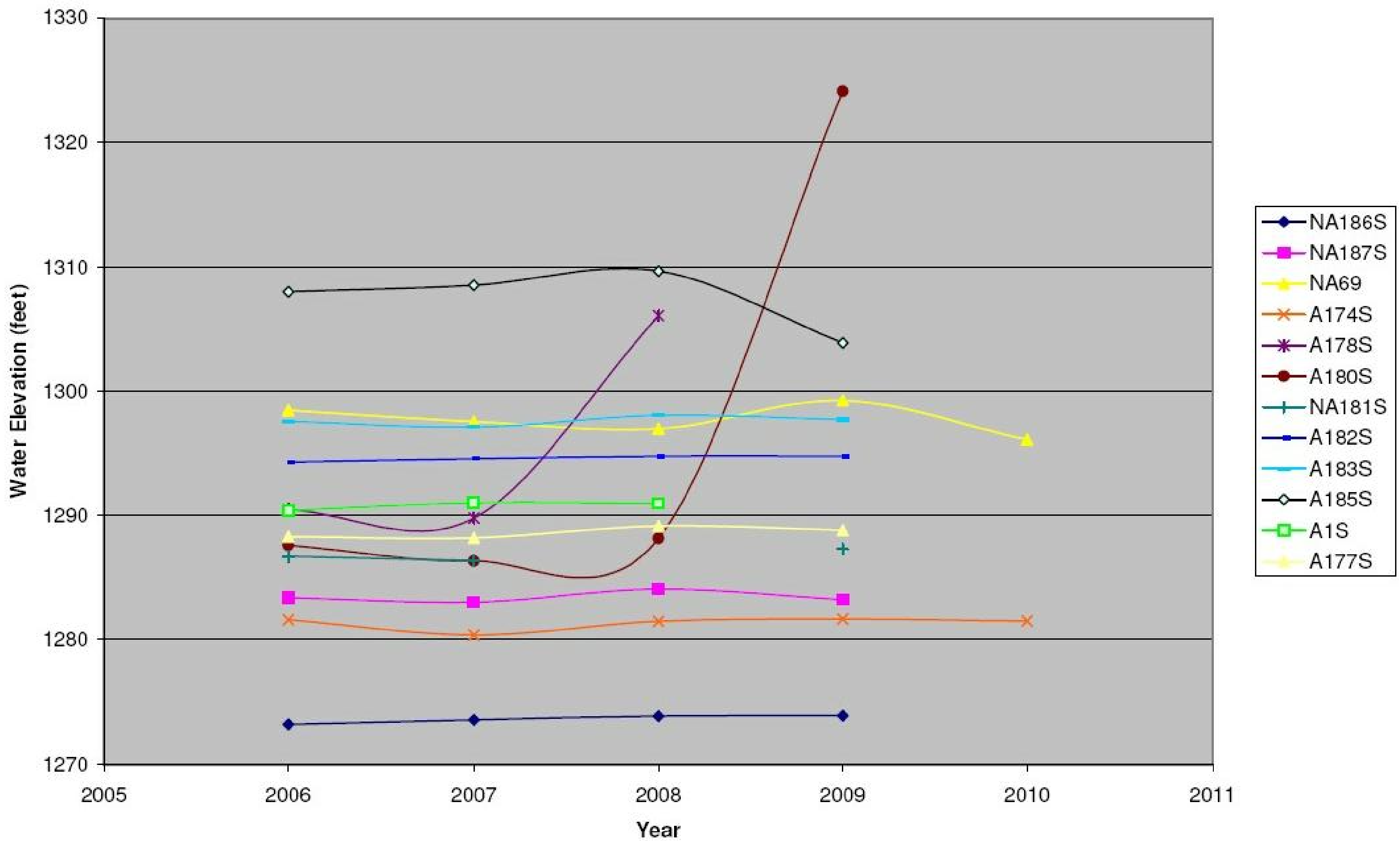
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 6/13/10
TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN. INACTIVE BOTTOM ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0174.0300
	PROJECTION:	SCALE:	PAGE NO. B-33

APPENDIX C
MONITORING WELL DATA GRAPHS

Monitoring Well Data - Operating Ash Pond Group Shallow Wells



Note: Graphs generated by AMEC from Water Elevation Summary Data provided by Minnesota Power

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental **690 Commonwealth Center** **11003 Bluegrass Parkway** **Louisville, Ky 40299** **(502) 267-0700**	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN MONITORING WELL DATA-OPERATING ASH POND GROUP SHALLOW WELLS	PROJECT NO: 3-2106-0174.0300 APPENDIX: C-1

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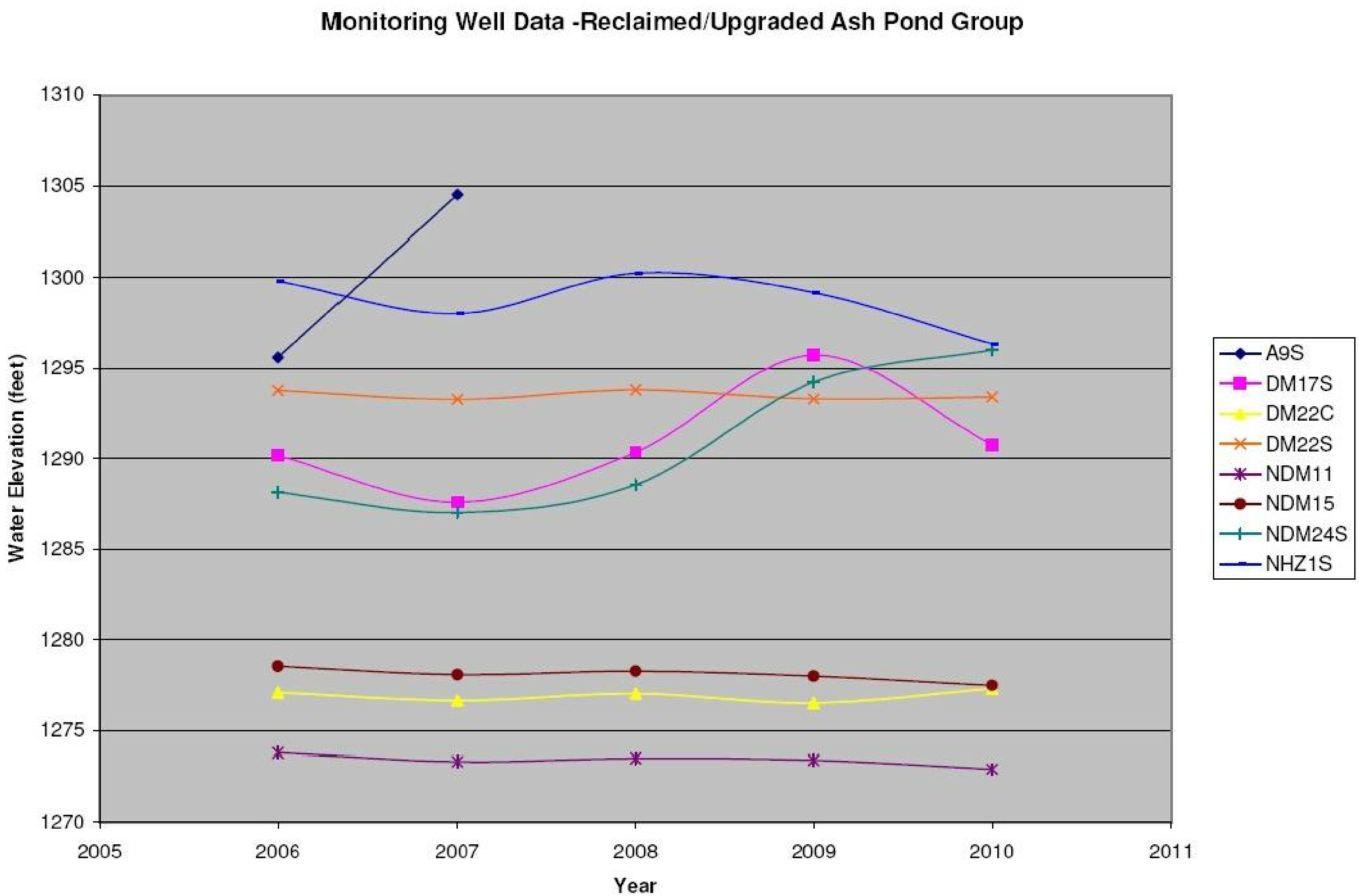

Note: Graphs generated by AMEC from Water Elevation Summary Data provided by Minnesota Power

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN MONITORING WELL DATA-RECLAIMED/UPGRADED ASH POND GROUP SHALLOW WELLS	PROJECT NO: 3-2106-0174.0300 APPENDIX: C-2

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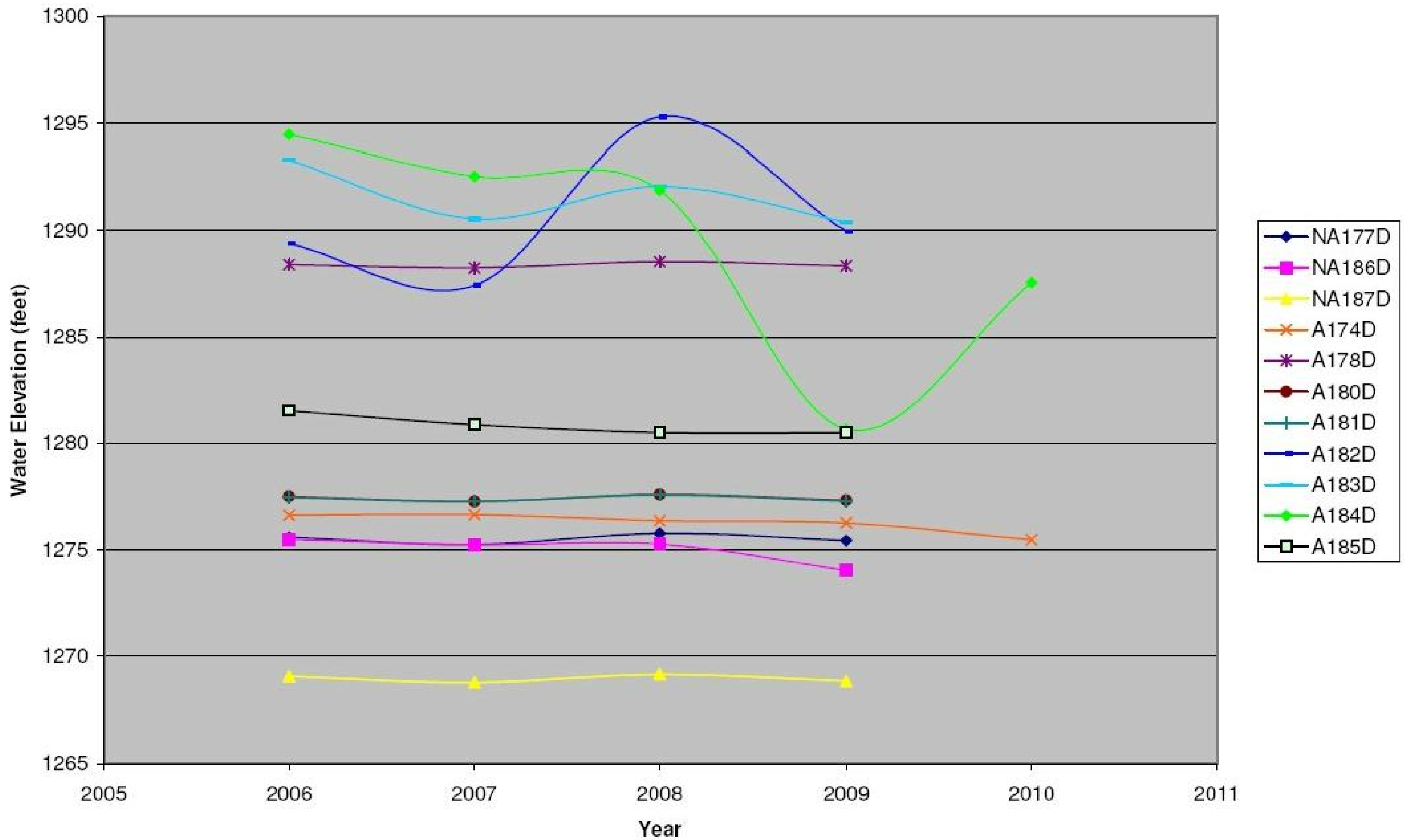
Monitoring Well Data - Operating Ash Pond Group Deep Wells



Note: Graphs generated by AMEC from Water Elevation Summary Data provided by Minnesota Power

CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700		DATUM: PROJECTION: SCALE: AS SHOWN	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN MONITORING WELL DATA-OPERATING ASH POND GROUP DEEP WELLS	PROJECT NO: 3-2106-0174.0300 APPENDIX C-3

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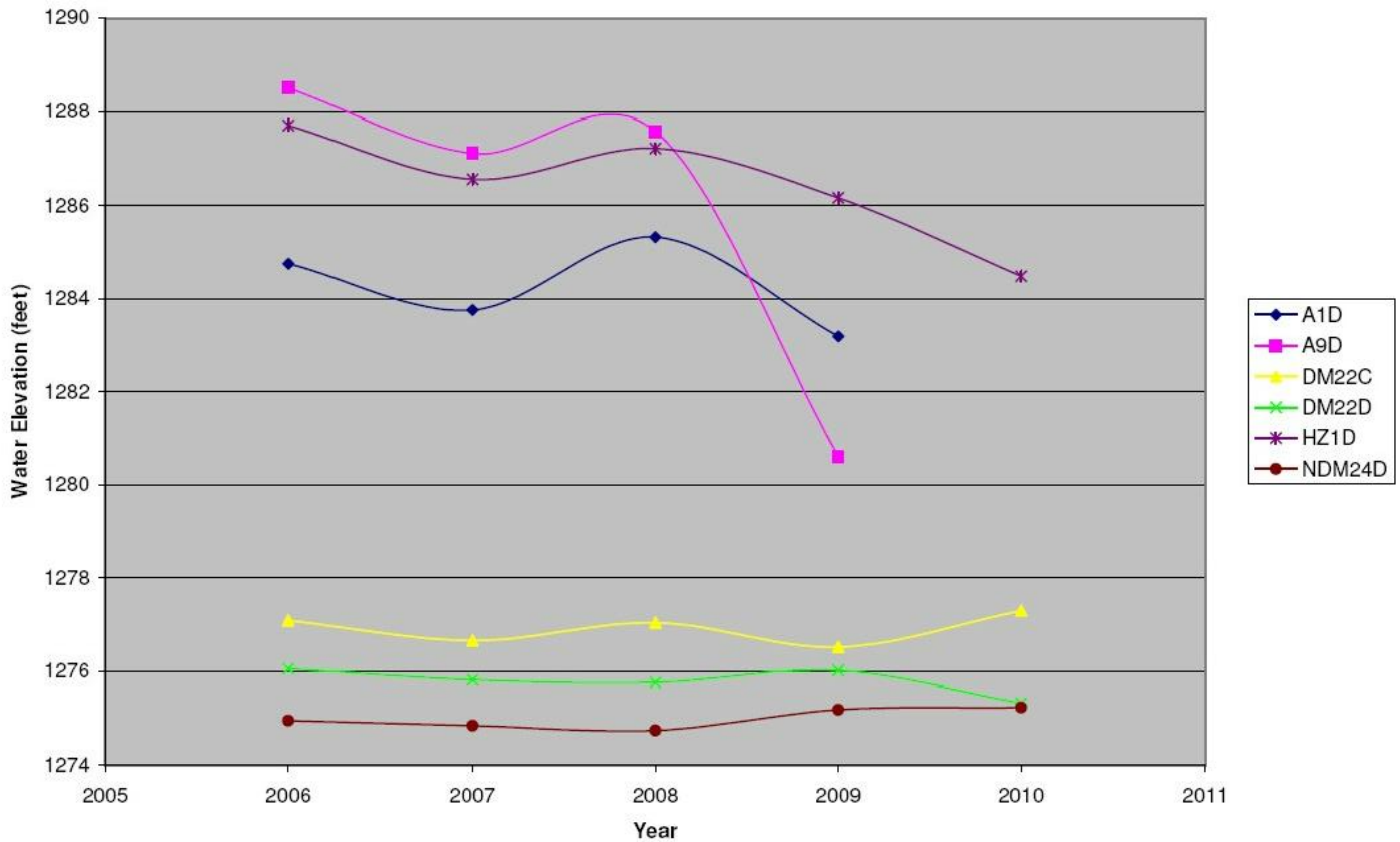
Monitoring Well Data - Reclaimed/Upgraded Ash Pond Group Deep Wells



Note: Graphs generated by AMEC from Water Elevation Summary Data provided by Minnesota Power

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN MONITORING WELL DATA-RECLAIMED/UPGRADED ASH POND GROUP DEEP WELLS

REV. NO.: A
DATE: 6/10/10
PROJECT NO: 3-2106-0174.0300
APPENDIX: C-4

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Boswell Groundwater Shallow Well Average Water Elevation Summary

	Operating Ash Pond Group													*Reclaimed/Upgraded Ash Pond Group*								
Year	*NA186S FEET*	*NA187S FEET*	*NA69 FEET*	*A174S FEET*	*A177S FEET*	*A178S FEET*	*A180S FEET*	*NA181S FEET*	*A181S FEET*	*A182S FEET*	*A183S FEET*	*A185S FEET*	*A1S FEET*	*A9S FEET*	*DM17 FEET*	*DM22C FEET*	*DM22S FEET*	*HZ1S FEET*	*NDM11 FEET*	*NDM15 FEET*	*NDM24S FEET*	*NHZ1S FEET*
2006	1273.27	1283.38	1298.48	1281.60	1288.30		1287.60	1286.71		1294.30	1297.60	1308.05			1290.16	1277.09	1293.78		1273.80	1278.54	1288.14	1299.80
2007	1273.63	1283.01	1297.57	1280.38	1288.20	1290.47	1286.34	1286.37		1294.56	1297.13	1308.57	1290.39		1287.60	1276.66	1293.27		1273.33	1278.08	1287.04	1298.00
2008	1273.94	1284.07	1296.99	1281.48	1289.16	1289.79	1288.15			1294.76	1298.07	1309.70	1291.02	1295.59	1290.37	1277.04	1293.80		1273.51	1278.28	1288.56	1300.23
2009	1273.99	1283.22	1299.28	1281.66	1288.82	1306.10	1324.10	1287.29		1294.76	1297.73	1303.92	1290.98	1304.50	1295.71	1276.52	1293.30		1273.41	1278.00	1294.23	1299.17
2010			1296.12	1281.50											1290.78	1277.30	1293.41		1272.93	1277.49	1296.00	1296.33
AVG for PERIOD	1273.71	1283.42	1297.88	1281.31	1288.62	1295.45	1296.55	1286.79		1294.60	1297.63	1307.56	1290.80	1300.04	1291.84	1276.87	1293.53		1273.44	1278.14	1290.43	1299.01
MIN for PERIOD	1273.27	1283.01	1296.12	1280.15	1288.20	1289.79	1286.34	1286.37		1294.30	1297.13	1303.92	1290.39	1295.59	1287.60	1275.03	1291.43		1272.93	1277.49	1286.20	1296.33
MAX for PERIOD	1273.99	1284.07	1304.01	1282.05	1289.16	1306.10	1324.10	1287.29		1294.76	1298.07	1309.70	1291.02	1304.50	1296.90	1277.98	1295.03		1273.89	1278.78	1296.00	1301.14
STDEV for PERIOD	0.33	0.46	2.06	0.65	0.45	9.23	18.38	0.47		0.22	0.39	2.52	0.35	6.30	3.68	0.90	1.03		0.31	0.38	3.91	1.47
RELSTDEV% for PERIOD	0.03	0.04	0.16	0.05	0.04	0.71	1.42	0.04		0.02	0.03	0.19	0.03	0.48	0.28	0.07	0.08		0.02	0.03	0.30	0.11

CLIENT LOGO

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Louisville, Ky 40299
(502) 267-0700

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DWN BY: CAE
CHK'D BY: MGS
DATUM:
PROJECTION:
SCALE: AS SHOWN

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
BOSWELL GROUNDWATER SHALLOW WELL AVERAGE WATER ELEVATION SUMMARY

REV. NO.: A
DATE: 6/10/10
PROJECT NO: 3-2106-0174.0300
APPENDIX C-5

Boswell Groundwater Deep Well Average Water Elevation Summary

	Operating Ash Pond Group												Reclaimed/Upgraded Ash Pond Group					
Year	A177D FEET	NA177D FEET	NA186D FEET	NA187D FEET	A174D FEET	A178D FEET	A180D FEET	A181D FEET	A182D FEET	A183D FEET	A184D FEET	A185D FEET	A1D FEET	A9D FEET	DM22C FEET	DM22D FEET	HZ1D FEET	NDM24D FEET
2006		1275.59	1275.49	1269.05	1276.63	1288.41	1277.50	1277.46	1289.40	1293.35	1294.48	1281.55	1284.75	1288.50	1277.09	1276.06	1287.71	1274.96
2007		1275.24	1275.23	1268.76	1276.65	1288.25	1277.27	1277.27	1287.43	1290.55	1292.54	1280.88	1283.76	1287.11	1276.66	1275.82	1286.56	1274.85
2008		1275.77	1275.27	1269.15	1276.37	1288.55	1277.60	1277.58	1295.30	1292.08	1291.89	1280.51	1285.32	1287.58	1277.04	1275.77	1287.22	1274.75
2009		1275.43	1274.03	1268.83	1276.26	1288.35	1277.33	1277.28	1289.97	1290.41	1280.67	1280.51	1283.19	1280.61	1276.52	1276.02	1286.16	1275.19
2010					1275.46						1287.55				1277.30	1275.33	1284.48	1275.24
AVG for period		1275.51	1275.01	1268.95	1276.38	1288.39	1277.42	1277.40	1290.52	1291.60	1289.02	1280.86	1284.26	1285.95	1276.87	1275.87	1286.65	1274.96
MIN for period		1275.24	1274.03	1268.76	1275.46	1288.25	1277.27	1277.27	1287.43	1290.41	1270.43	1280.51	1283.19	1280.61	1275.03	1275.22	1284.48	1274.48
MAX for period		1275.77	1275.49	1269.15	1276.86	1288.55	1277.60	1277.58	1295.30	1293.35	1295.10	1281.55	1285.32	1288.50	1277.98	1276.40	1288.12	1275.31
STDEV for period		0.23	0.66	0.18	0.42	0.13	0.15	0.15	3.36	1.39	7.04	0.49	0.96	3.61	0.90	0.38	1.15	0.25
RELSTDEV% for period		0.02	0.05	0.01	0.03	0.01	0.01	0.01	0.26	0.11	0.55	0.04	0.07	0.28	0.07	0.03	0.09	0.02

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

DWN BY: CAE
CHK'D BY: MGS
DATUM:
PROJECTION:
SCALE: AS SHOWN

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
BOSWELL GROUNDWATER DEEP
WELL AVERAGE WATER ELEVATION SUMMARY

REV. NO.: A
DATE: 6/10/10
PROJECT NO: 3-2106-0174.0300
APPENDIX C-6

APPENDIX D
ACTIVE ASH POND HORIZONTAL AND VERTICAL MONITORING DATA

Imagery Source: NAIP, 2008

Feet
1,000 0 1,000 2,000 3,000

Meters
250 0 250 500 750

Figure 1

MOVEMENT MONITORING DATA REVIEW
Embankment Inspection
Minnesota Power - Boswell
Grand Rapids, MN

CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN MOVEMENT MONITORING STATION LOCATIONS	PROJECT NO: 3-2106-0174.0300 APPENDIX D-1

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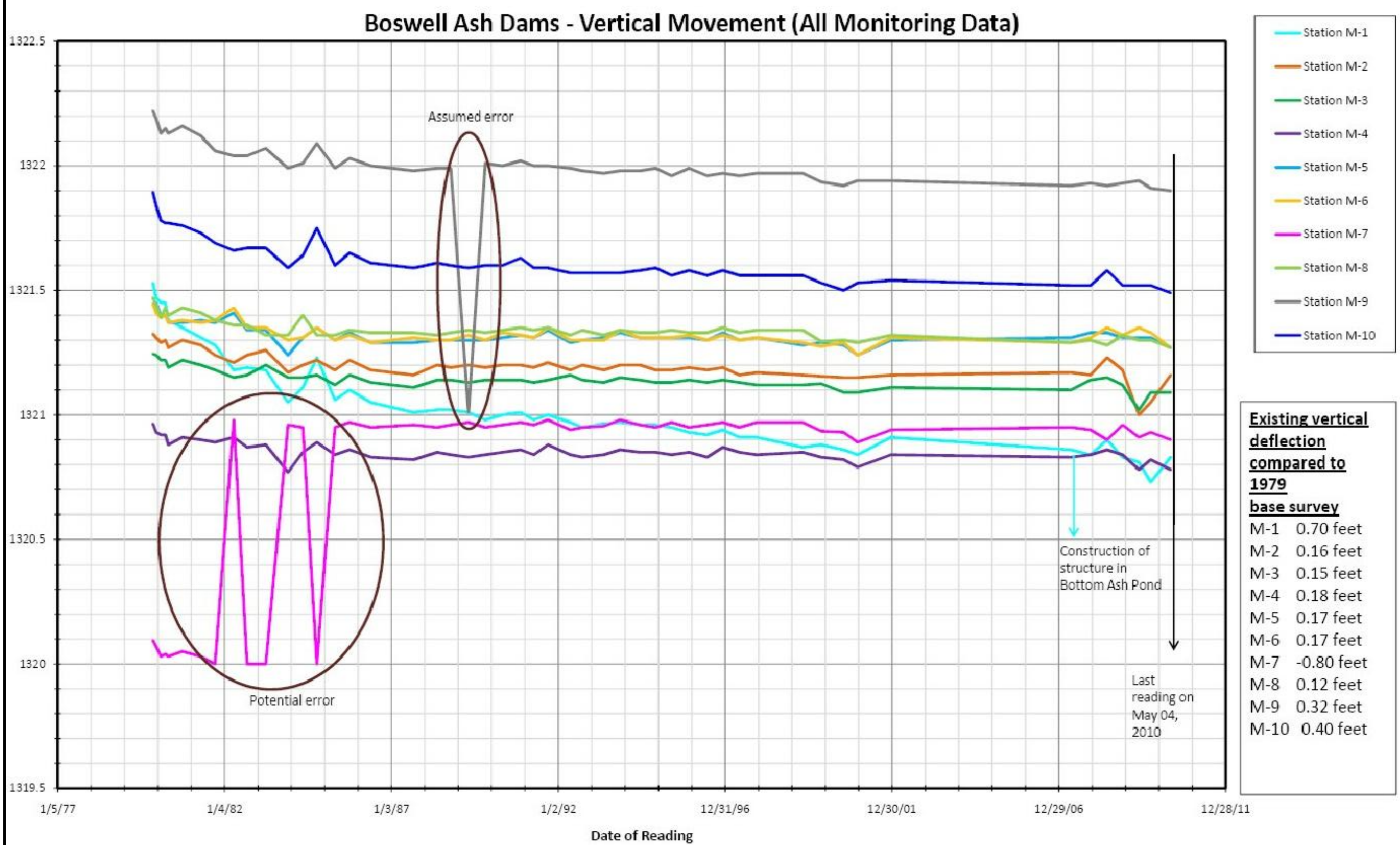

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN VERTICAL MOVEMENT (ALL MONITORING DATA)	PROJECT NO: 3-2106-0174.0300 APPENDIX D-2

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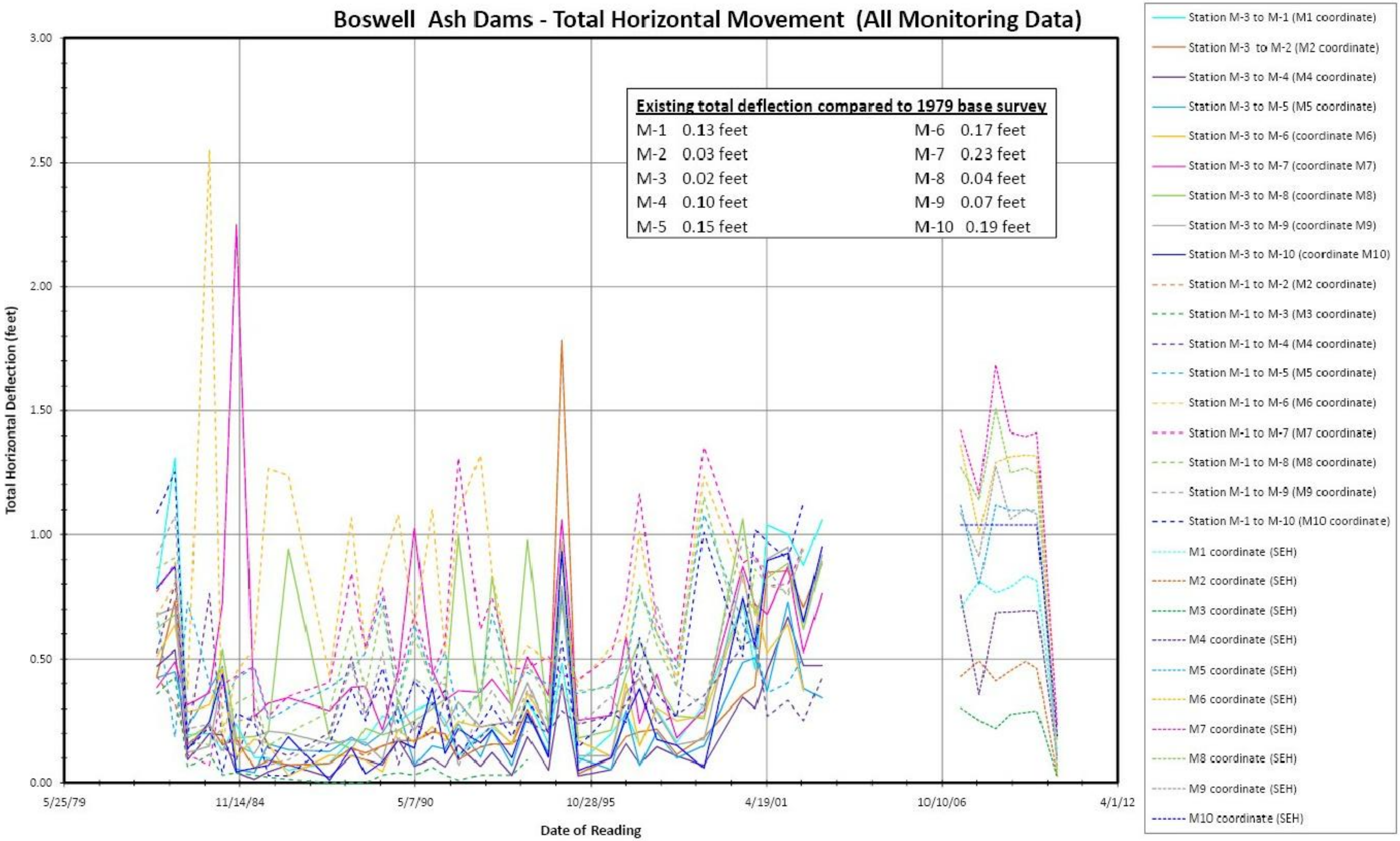

CLIENT LOGO

CLIENT
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Louisville, Ky 40299
(502) 267-0700

amec

DWN BY: CAE
CHK'D BY: MGS
DATUM:
PROJECTION:
SCALE: AS SHOWN

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
TOTAL HORIZONTAL MOVEMENT
(ALL MONITORING DATA)

REV. NO.: A
DATE: 6/10/10
PROJECT NO: 3-2106-0174.0300
APPENDIX D-3

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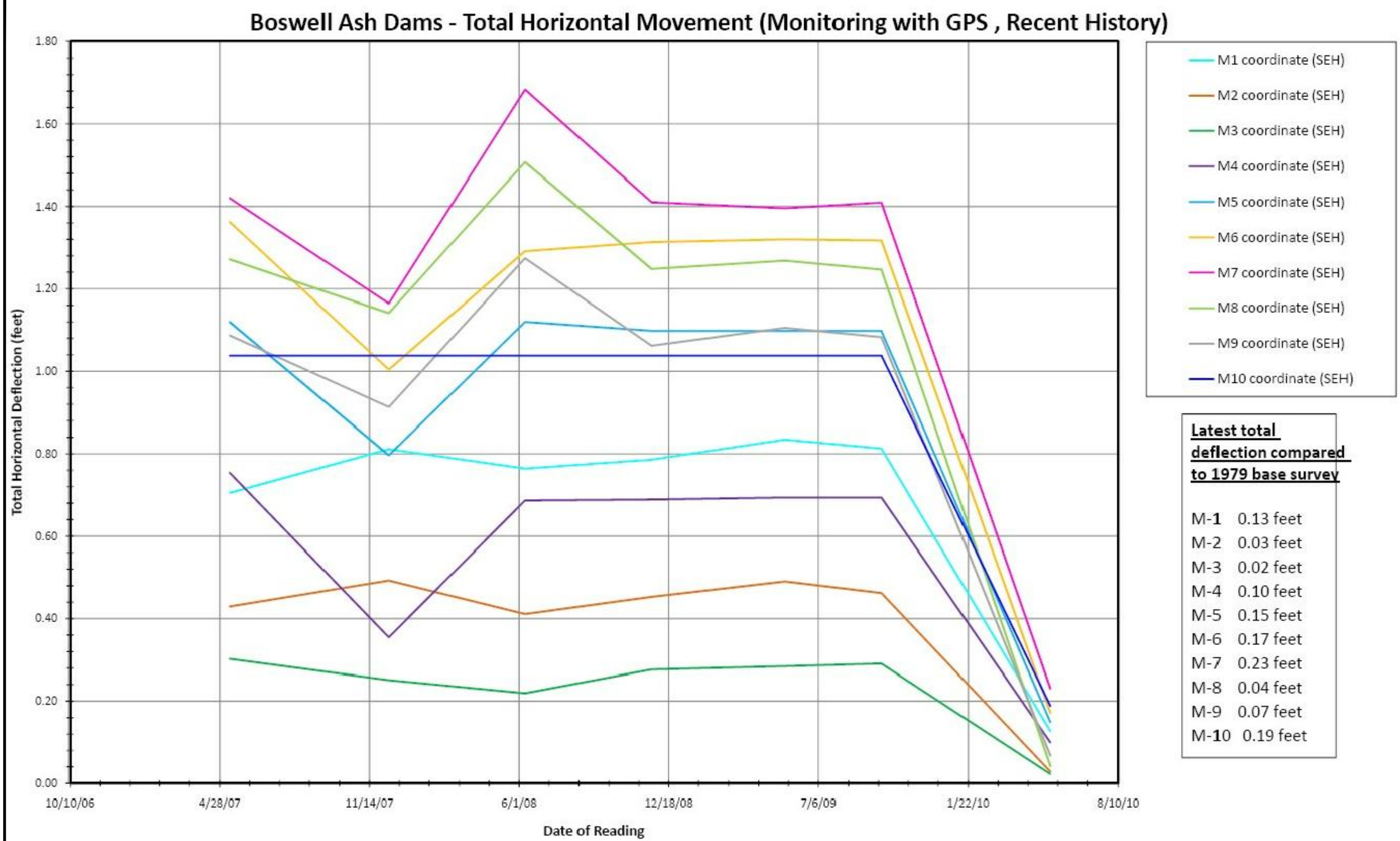

CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A	
		CHK'D BY: MGS		DATE: 6/10/10	
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700		DATUM:	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN TOTAL HORIZONTAL MOVEMENT (MONITORING WITH GPS, RECENT HISTORY)	PROJECT NO: 3-2106-0174.0300	
		PROJECTION:		APPENDIX D-4	
		SCALE: AS SHOWN			

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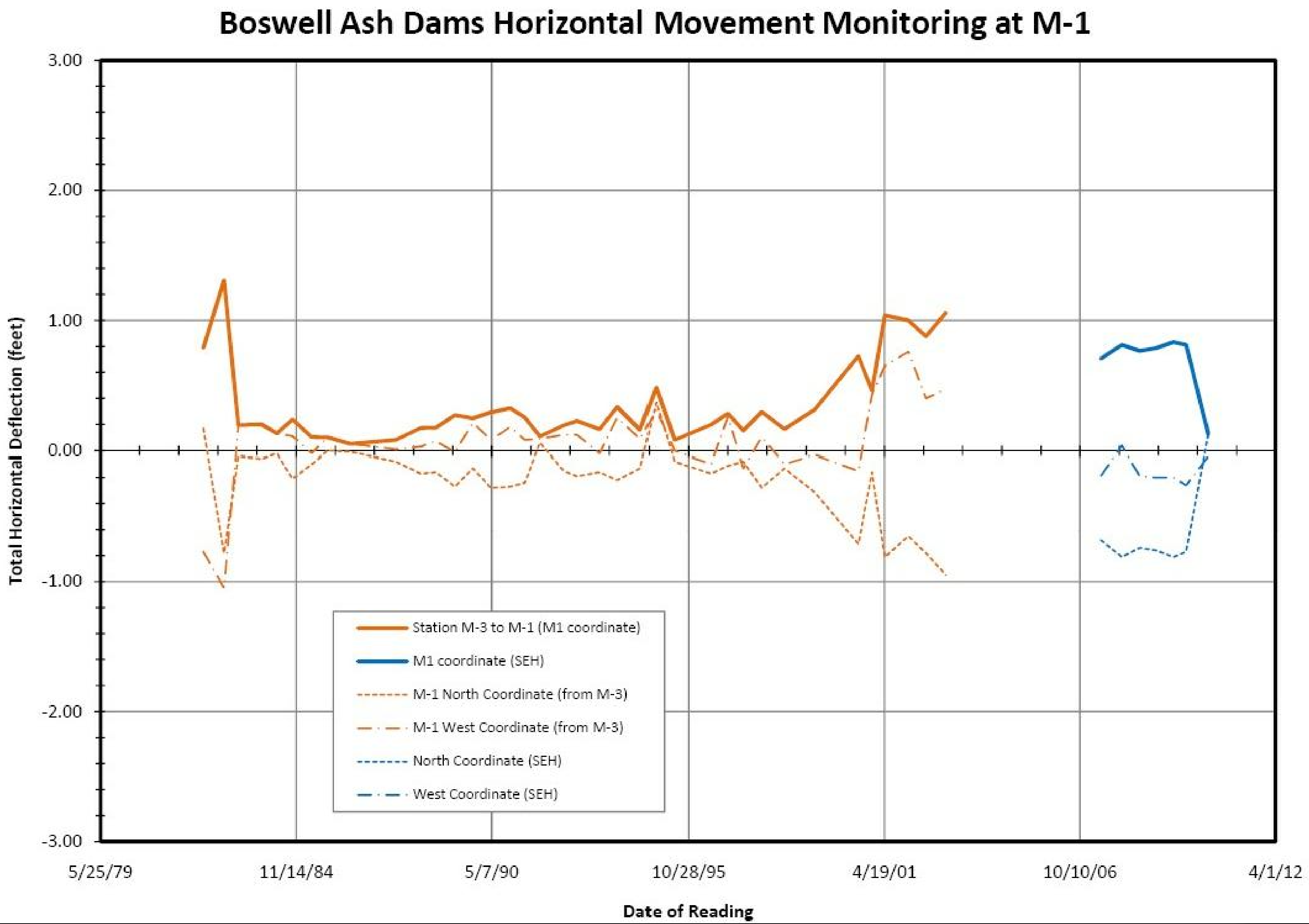

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN HORIZONTAL MOVEMENT MONITORING AT M-1	PROJECT NO: 3-2106-0174.0300 APPENDIX: D-5

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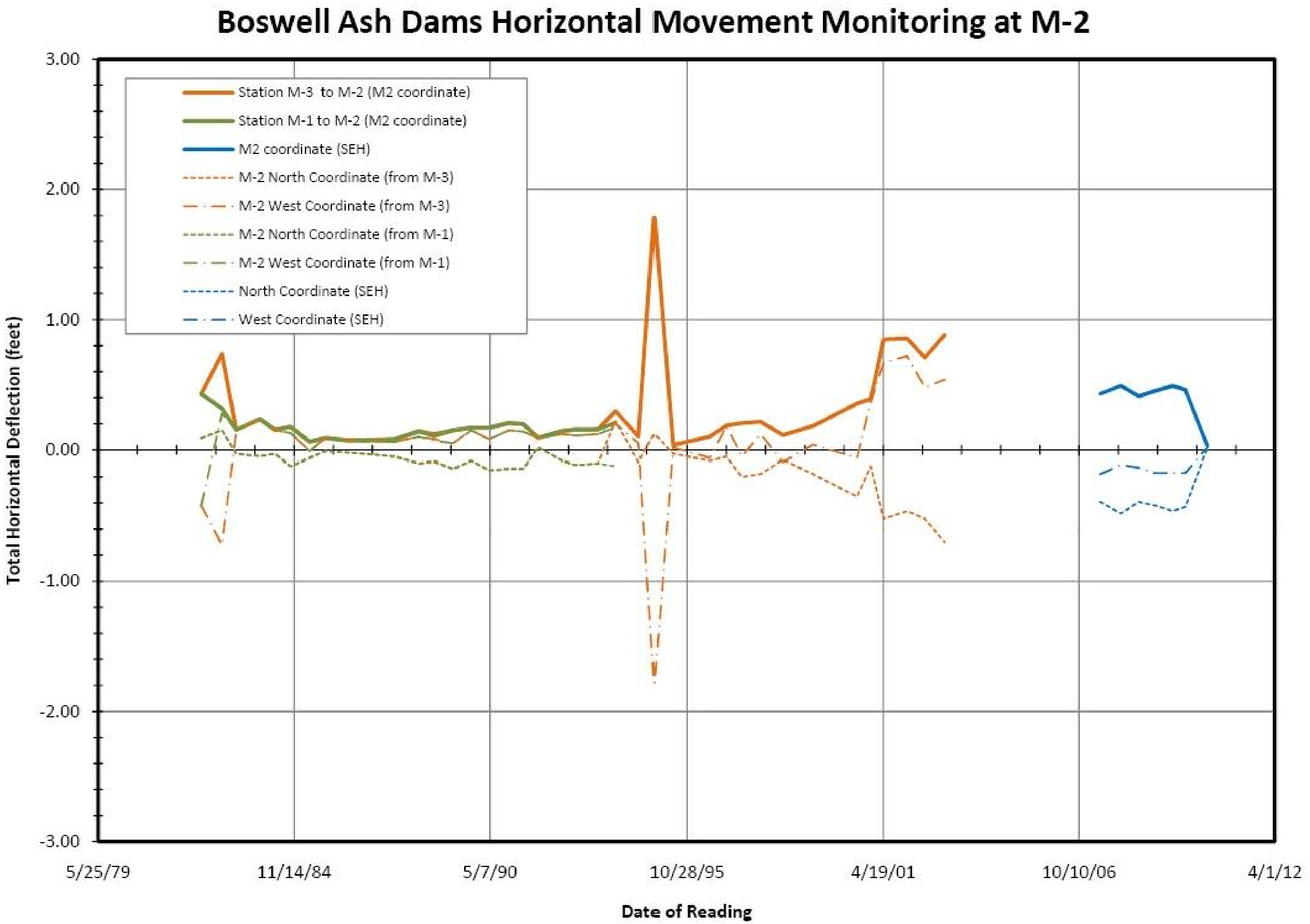

CLIENT LOGO

CLIENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental

690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

amec

DWN BY:	CAE
CHK'D BY:	MGS
DATUM:	
PROJECTION:	
SCALE:	AS SHOWN

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
HORIZONTAL MOVEMENT MONITORING AT M-2

REV. NO.:	A
DATE:	6/10/10
PROJECT NO:	3-2106-0174.0300
APPENDIX	D-6

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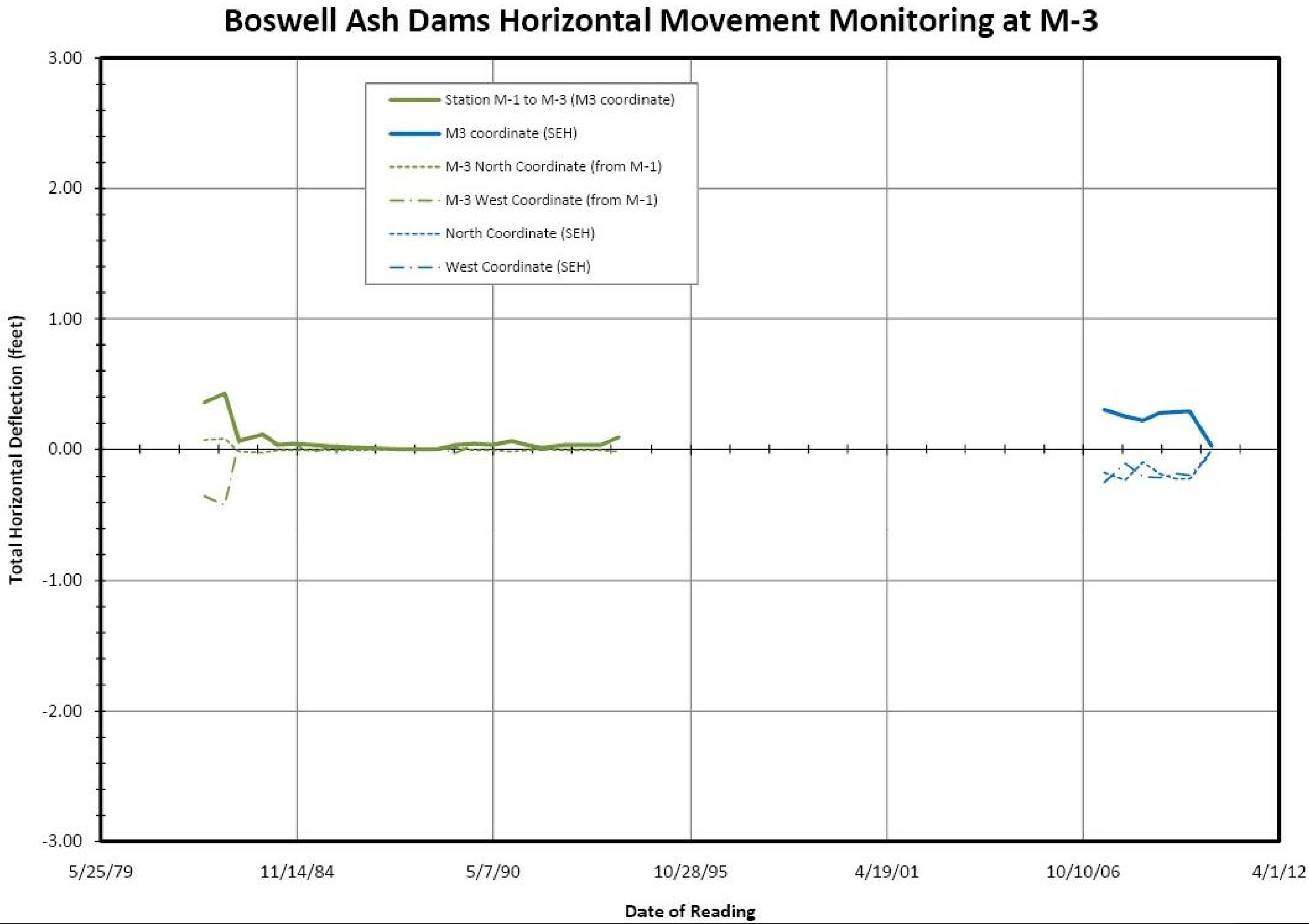

CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN HORIZONTAL MOVEMENT MONITORING AT M-3	PROJECT NO: 3-2106-0174.0300 APPENDIX D-7

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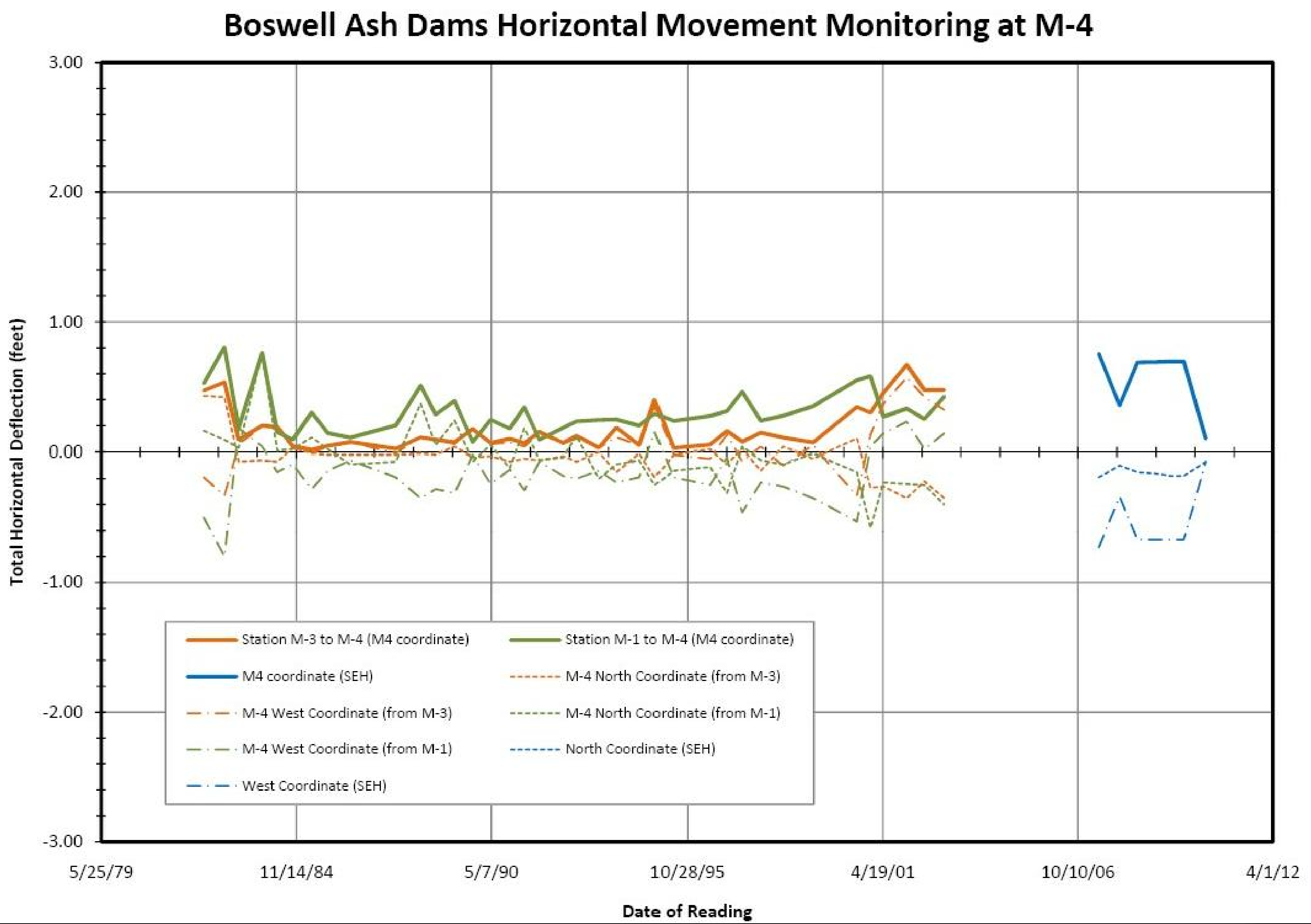

CLIENT LOGO	CLIENT	DWN BY: CAE	PROJECT	REV. NO.: A
	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	CHK'D BY: MGS	ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM:	TITLE	PROJECT NO: 3-2106-0174.0300
		PROJECTION:	MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN HORIZONTAL MOVEMENT MONITORING AT M-4	APPENDIX D-8
		SCALE: AS SHOWN		

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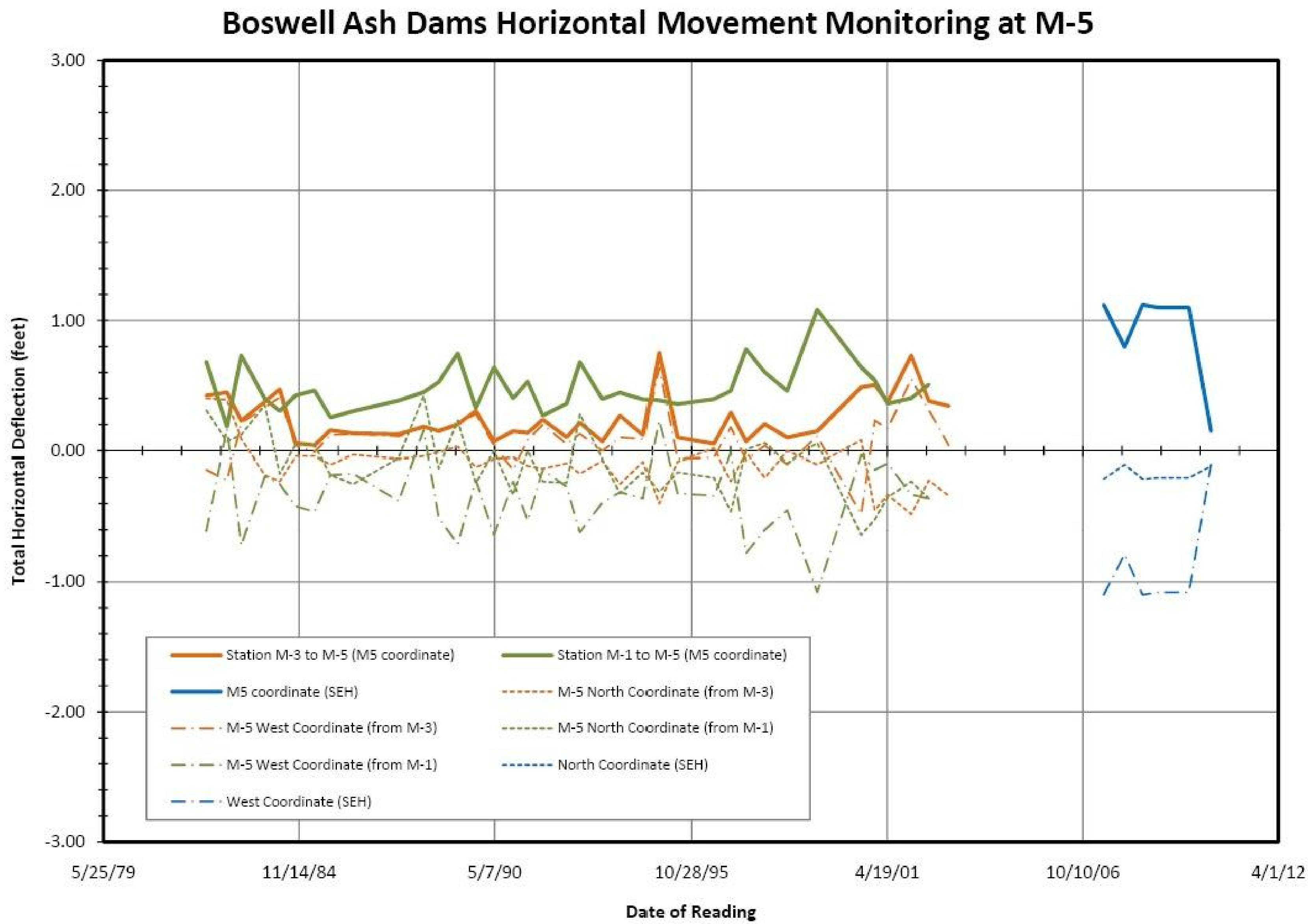

CLIENT LOGO

CLIENT
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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690 Commonwealth Center
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Louisville, Ky 40299
(502) 267-0700

amec

DWN BY: CAE
CHK'D BY: MGS
DATUM:
PROJECTION:
SCALE: AS SHOWN

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
HORIZONTAL MOVEMENT MONITORING AT M-5

REV. NO.: A
DATE: 6/10/10
PROJECT NO: 3-2106-0174.0300
APPENDIX D-9

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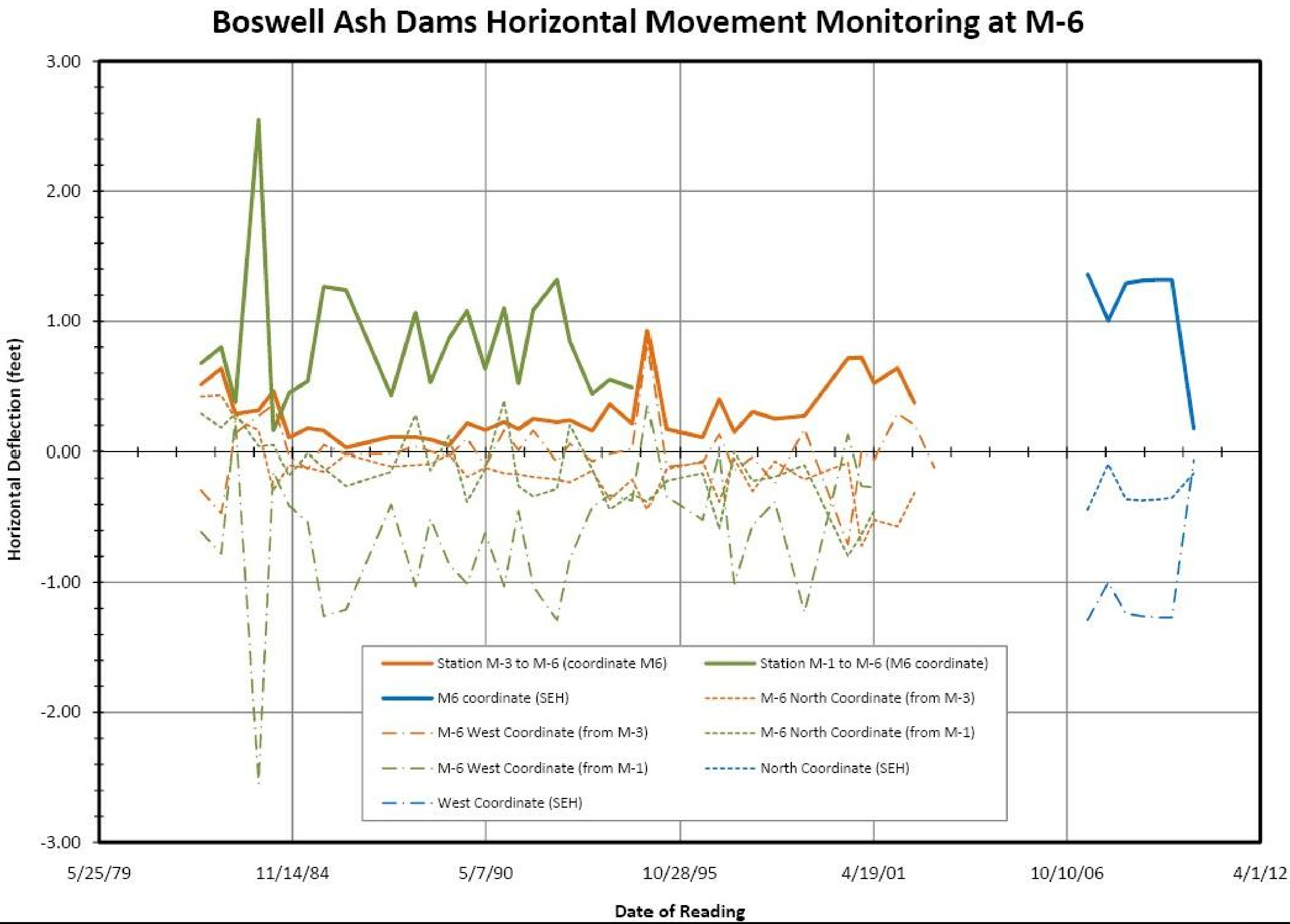

CLIENT LOGO

CLIENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental

690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

amec

DWN BY: CAE

CHK'D BY: MGS

DATUM:

PROJECTION:

SCALE: AS SHOWN

PROJECT

ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE

MINNESOTA POWER
BOSWELL ENERGY CENTER, COHASSET, MN
HORIZONTAL MOVEMENT MONITORING AT M-6

REV. NO.: A

DATE: 6/10/10

PROJECT NO: 3-2106-0174.0300

APPENDIX D-10

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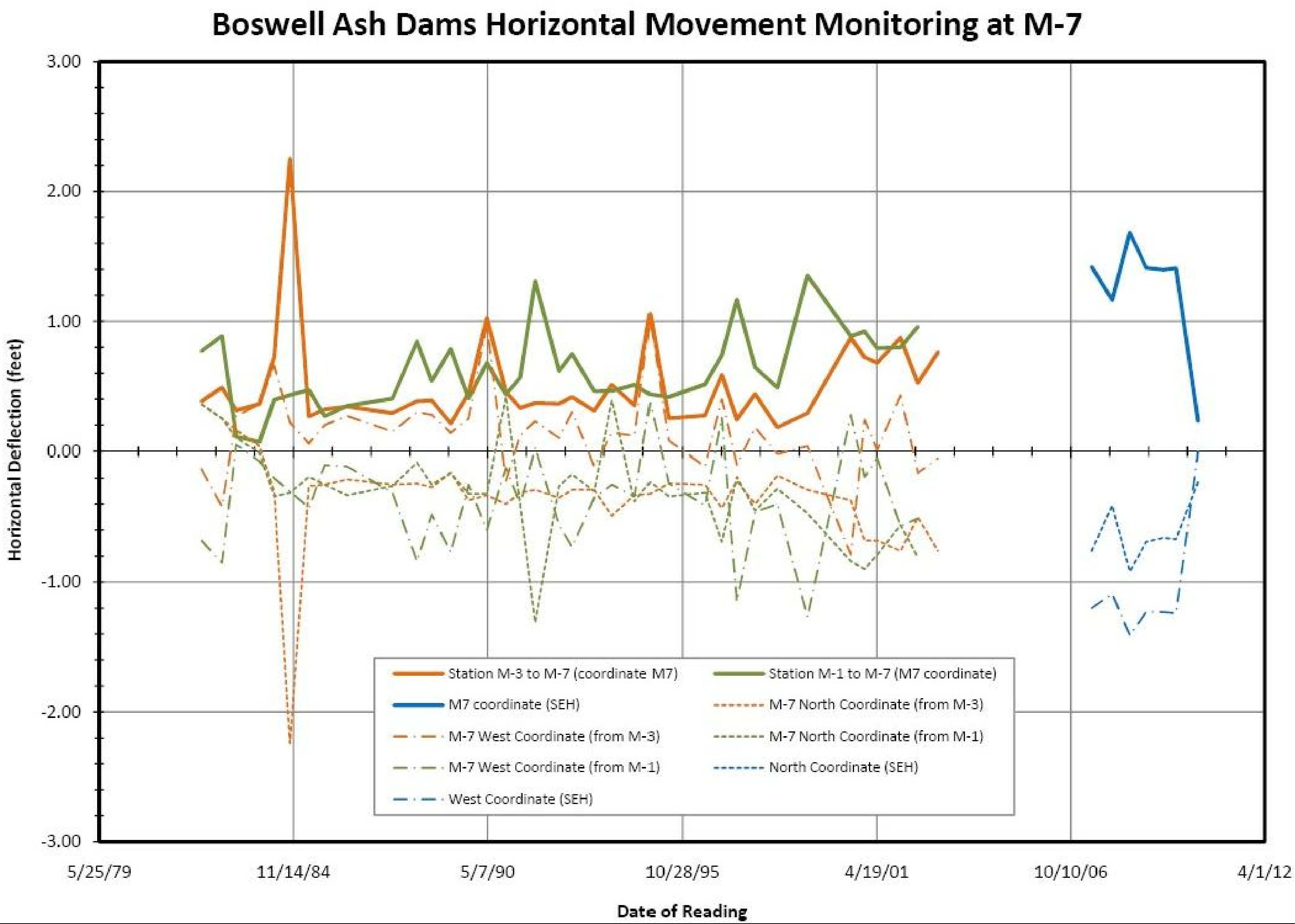

CLIENT LOGO	CLIENT	DWN BY: CAE	PROJECT	REV. NO.: A
	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	CHK'D BY: MGS	ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM:	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN HORIZONTAL MOVEMENT MONITORING AT M-7	PROJECT NO: 3-2106-0174.0300
		PROJECTION:		APPENDIX
		SCALE: AS SHOWN		D-11

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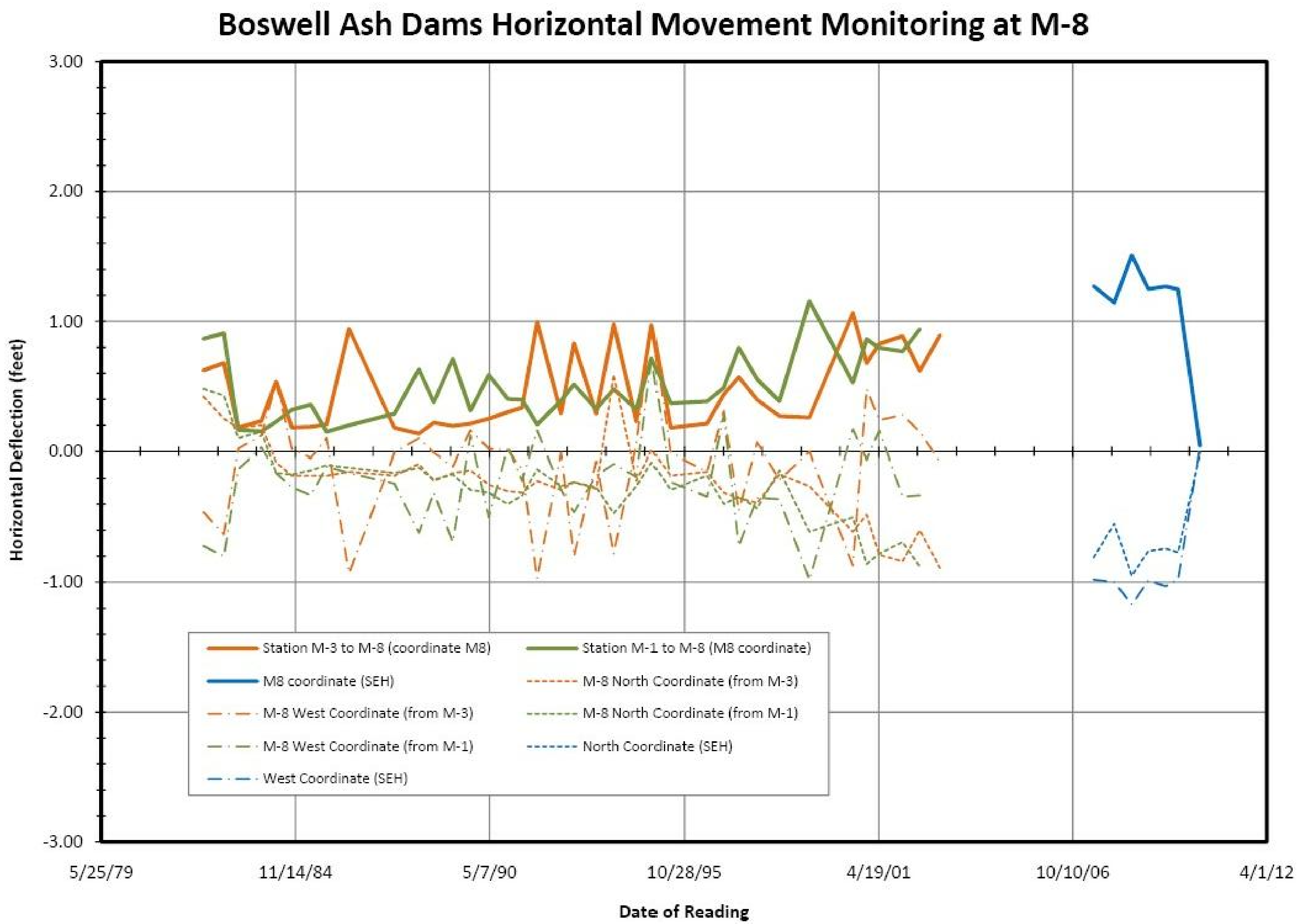
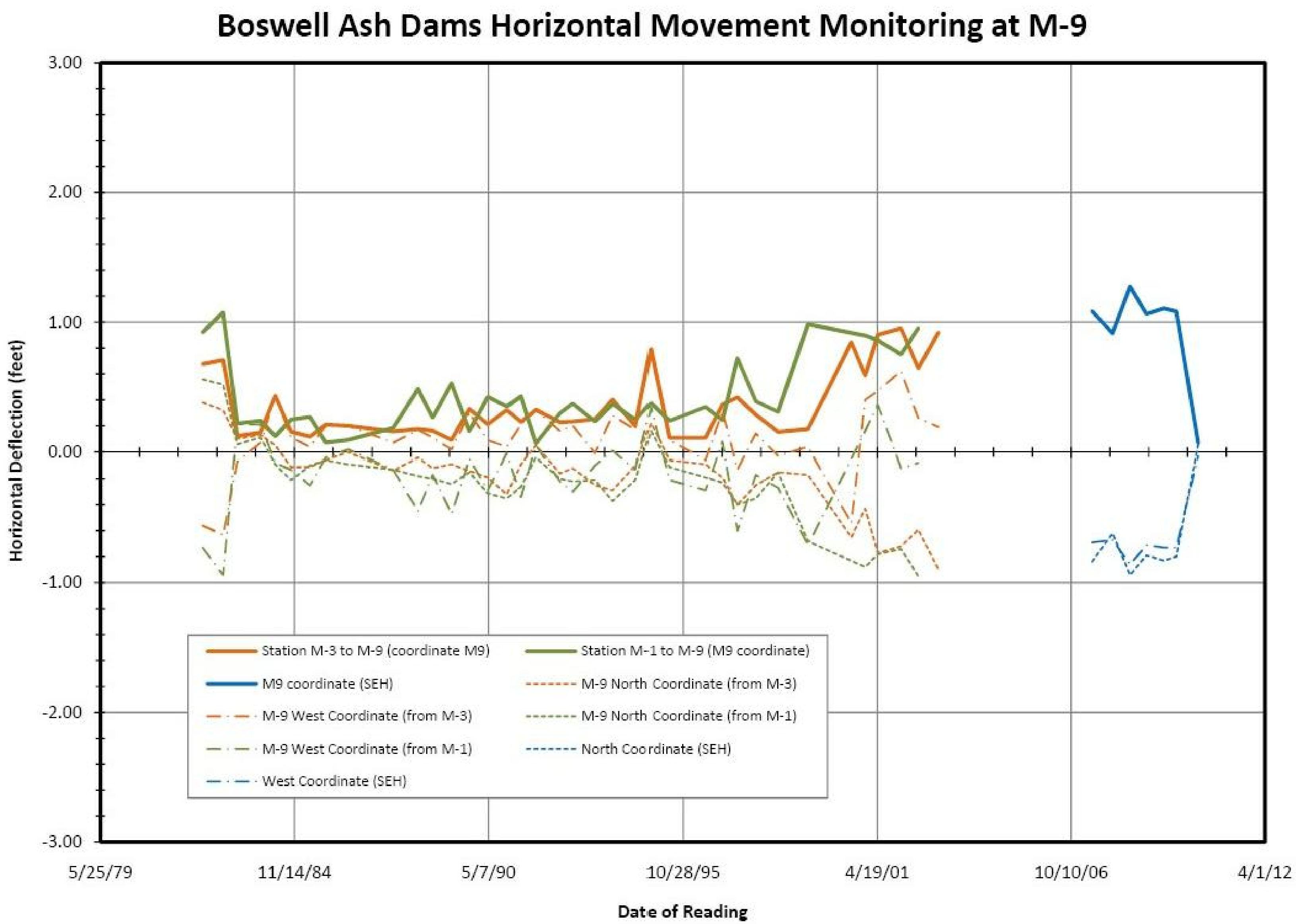


CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A	
		CHK'D BY: MGS		DATE: 6/10/10	
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM:	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN HORIZONTAL MOVEMENT MONITORING AT M-8	PROJECT NO: 3-2106-0174.0300	
		PROJECTION:		APPENDIX D-12	
		SCALE: AS SHOWN			



CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE: AS SHOWN	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN HORIZONTAL MOVEMENT MONITORING AT M-9	PROJECT NO: 3-2106-0174.0300 APPENDIX D-13

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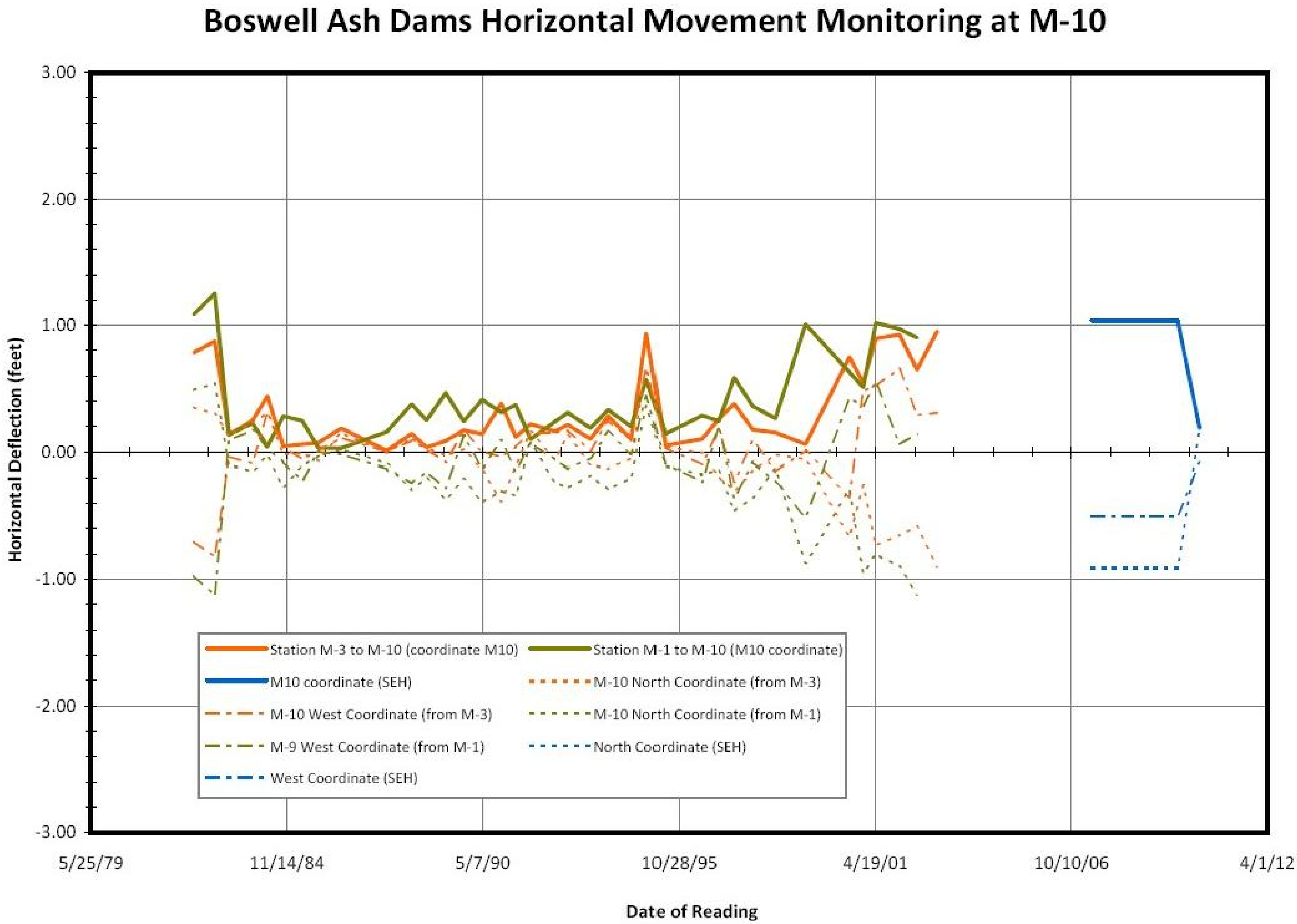

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/10/10
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700		DATUM: PROJECTION: SCALE: AS SHOWN	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN HORIZONTAL MOVEMENT MONITORING AT M-10	PROJECT NO: 3-2106-0174.0300 APPENDIX: D-14

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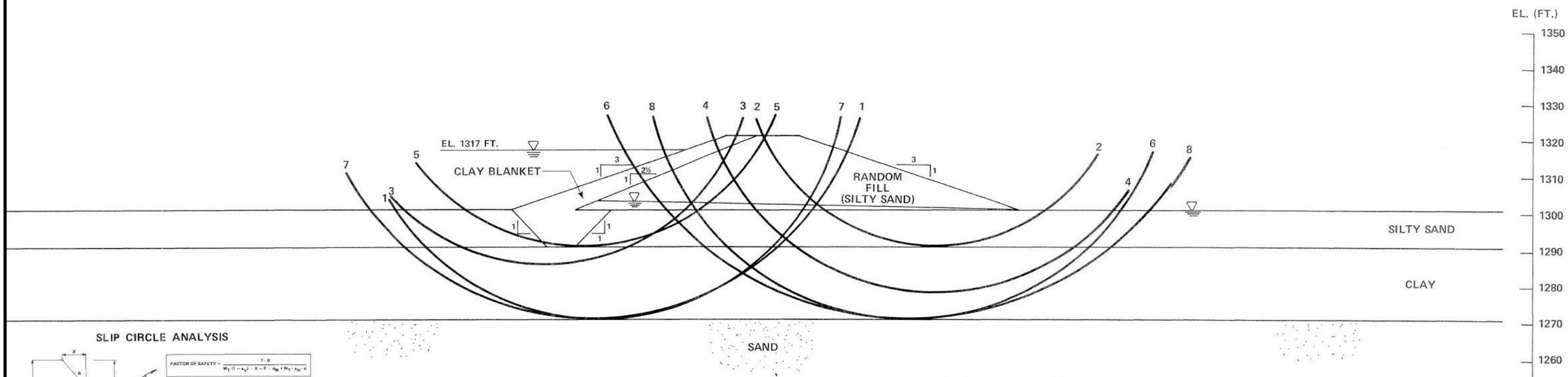
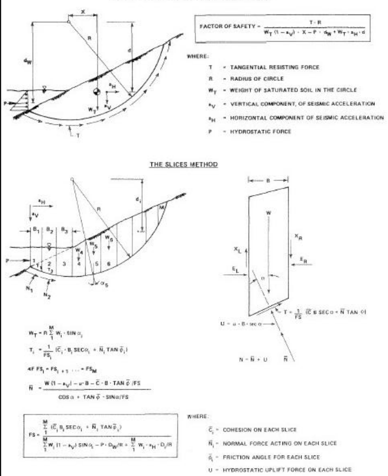
APPENDIX E
STABILITY ANALYSIS CROSS SECTIONS



SLIP CIRCLE ANALYSIS



SOIL PROPERTIES

SOIL / CASE	CLAY RECOMPACTED C(psf)	CLAY RECOMPACTED φ(deg)	RANDOM FILL (SILTY SAND) C(psf)	RANDOM FILL (SILTY SAND) φ(deg)	CLAY IN-SITU C(psf)	CLAY IN-SITU φ(deg)	SAND IN-SITU C(psf)	SAND IN-SITU φ(deg)
UNDRAINED	1000	0	500	30	1200	0	0	40
DRAINED	500	20	500	30	500	20	0	40

NOTE: FAILURE SURFACES SHOWN ARE THE MOST CRITICAL FOR THEIR RESPECTIVE CASES.

SAFETY FACTORS FOR STABILITY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
5	UNDRAINED	STATIC SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	5.23
6	UNDRAINED	STATIC SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.95
3	DRAINED	STATIC LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	4.90
4	DRAINED	STATIC LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	3.14
1	UNDRAINED	STATIC SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	2.74
7	UNDRAINED	SEISMIC CASE (a_H = .05g, a_v = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	3.90
8	UNDRAINED	SEISMIC CASE (a_H = .05g, a_v = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.43
2	UNDRAINED	STATIC SHORT TERM CASE; POND EMPTY CONSTRUCTION CASE	2.71

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE:	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN SLIP CIRCLE SLOPE STABILITY ANALYSIS TYPICAL SECTION WEST DIKE

REV. NO.: A
DATE: 6/17/10
PROJECT NO: 3-2106-0174.0300
FIGURE No. E-1

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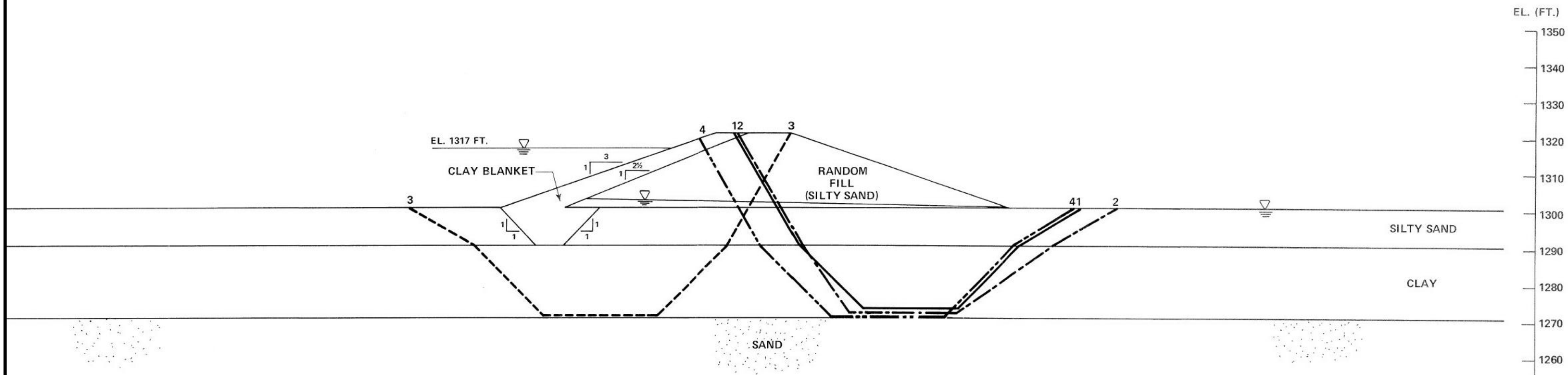
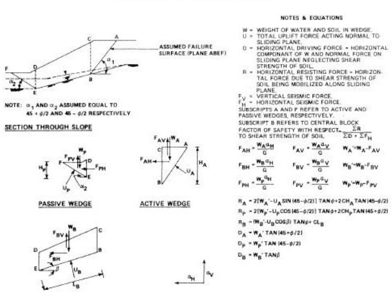


SAFETY FACTORS FOR STABILITY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
1	UNDRAINED	STATIC SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.46
2	DRAINED	STATIC LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.57
3	UNDRAINED	STATIC SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	2.14
4	UNDRAINED	SEISMIC CASE (a_H = .05g, a_V = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.09

SLIDING WEDGE ANALYSIS



SOIL PROPERTIES

CASE \ SOIL	CLAY RECOMPACTED		RANDOM FILL (SILTY SAND)		CLAY IN-SITU		SAND IN-SITU	
	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)
UNDRAINED	1000	0	500	30	1200	0	0	40
DRAINED	500	20	500	30	500	20	0	40

NOTE: FAILURE SURFACES SHOWN ARE THE MOST CRITICAL FOR THEIR RESPECTIVE CASES.

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE:	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN SLIDING WEDGE SLOPE STABILITY ANALYSIS TYPICAL SECTION WEST DIKE

REV. NO.: A
DATE: 6/17/10
PROJECT NO: 3-2106-0174.0300
FIGURE No. E-2

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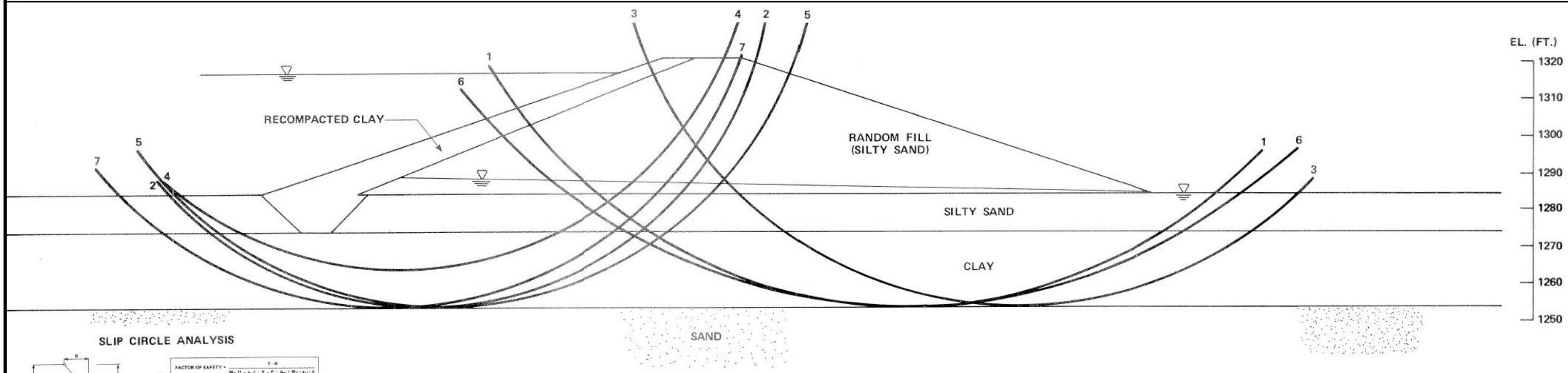
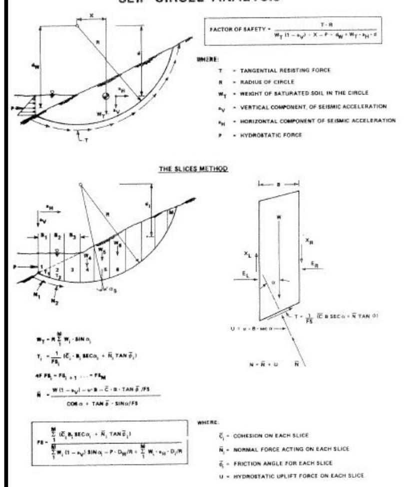


SLIP CIRCLE ANALYSIS



SAFETY FACTORS FOR STABILITY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
1	UNDRAINED	STATIC SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.41
2	UNDRAINED	STATIC SHORT TERM CASE: POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	3.03
3	DRAINED	STATIC LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.24
4	DRAINED	STATIC LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	3.63
5	UNDRAINED	STATIC SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	1.68
6	UNDRAINED	SEISMIC CASE (a_H = .05g, a_V = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.14
7	UNDRAINED	SEISMIC CASE (a_H = .05g, a_V = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.25

SOIL PROPERTIES

SOIL / CASE	CLAY RECOMPACTED		RANDOM FILL (SILTY SAND)		CLAY IN-SITU		SILTY SAND IN-SITU		SAND IN-SITU	
	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)
UNDRAINED	1000	0	500	30	900	0	500	30	0	40
DRAINED	500	20	500	30	350	20	500	30	0	40

NOTE: Failure surfaces shown are the most critical for their respective cases.

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	REV. NO.: A DATE: 6/17/10
AMEC Earth & Environmental **690 Commonwealth Center** **11003 Bluegrass Parkway** **Louisville, Ky 40299** **(502) 267-0700**	amec	DATUM: PROJECTION: SCALE:	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN SLIP CIRCLE SLOPE STABILITY ANALYSIS TYPICAL SECTION EAST DIKE	PROJECT NO: 3-2106-0174.0300 FIGURE No. E-3

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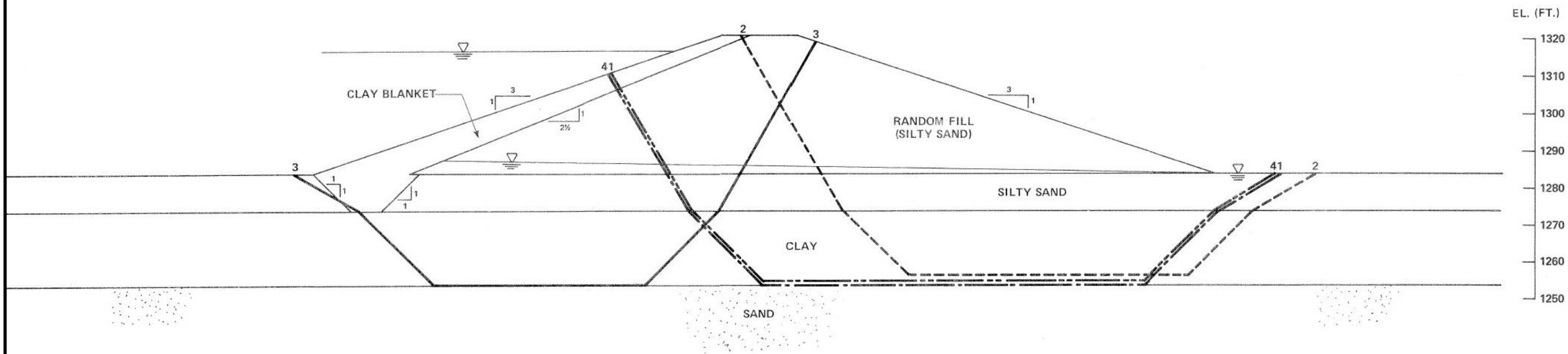
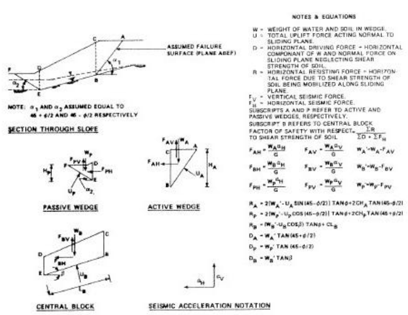


SLIDING WEDGE ANALYSIS



SAFETY FACTORS FOR STABILITY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
1	UNDRAINED	STATIC SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.19
2	DRAINED	STATIC LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.88
3	UNDRAINED	STATIC SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	1.53
4	UNDRAINED	SEISMIC CASE (a_H = .05g, a_V = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.09

SOIL PROPERTIES

SOIL / CASE	CLAY RECOMPACTED		RANDOM FILL (SILTY SAND)		CLAY IN-SITU		SILTY SAND IN-SITU		SAND IN-SITU	
	$C_{(psf)}$	$\phi_{(deg)}$	$C_{(psf)}$	$\phi_{(deg)}$	$C_{(psf)}$	$\phi_{(deg)}$	$C_{(psf)}$	$\phi_{(deg)}$	$C_{(psf)}$	$\phi_{(deg)}$
UNDRAINED	1000	0	500	30	900	0	500	30	0	40
DRAINED	500	20	500	30	350	20	500	30	0	40

NOTE: Failure surfaces shown are the most critical for their respective cases.

CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700		DATUM: PROJECTION: SCALE:	TITLE MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN SLIDING WEDGE SLOPE STABILITY ANALYSIS TYPICAL SECTION EAST DIKE

REV. NO.: A
DATE: 6/17/10
PROJECT NO: 3-2106-0174.0300
FIGURE No. E-4

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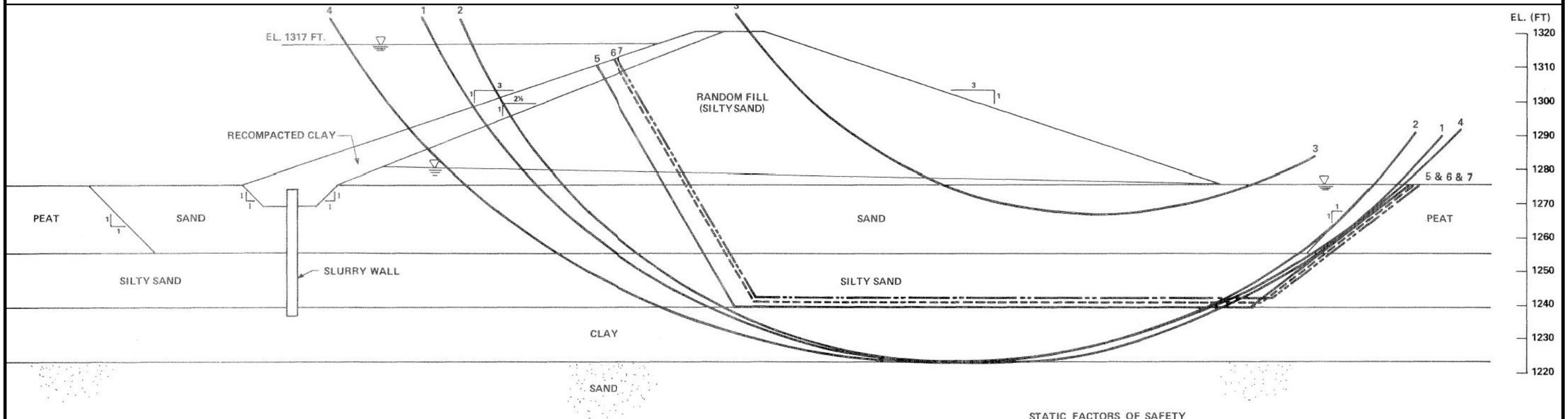

SEISMIC FACTORS OF SAFETY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
4	UNDRAINED	SEISMIC CASE (a_H = .05g, a_v = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.16
5*	UNDRAINED	SEISMIC CASE (a_H = .05g, a_v = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.25

*FROM WEDGE ANALYSIS

SOIL PROPERTIES

SOIL / CASE	CLAY RECOMPACTED		RANDOM FILL (SILTY SAND)		CLAY IN-SITU		SILTY SAND IN-SITU		SAND IN-SITU		PEAT IN-SITU	
	C(psf)	ϕ(deg)	C(psf)	ϕ(deg)	C(psf)	ϕ(deg)	C(psf)	ϕ(deg)	C(psf)	ϕ(deg)	C(psf)	ϕ(deg)
UNDRAINED	1000	0	500	30	900	0	500	30	0	40	250	15
DRAINED	500	20	500	30	350	20	500	30	0	40	250	15

STATIC FACTORS OF SAFETY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
1	UNDRAINED	SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.55
2	DRAINED	LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.42
3	UNDRAINED	SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	1.70
7*	UNDRAINED	SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.47
6*	UNDRAINED	SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	1.50

*FROM WEDGE ANALYSIS

NOTES:

1) THIS SECTION REPRESENTS A LOCALIZED LOW AREA ALONG THE EAST SIDE, THEREFORE THE HIGHEST EMBANKMENT ABOVE NATURAL GROUND.
2) FAILURE SURFACES SHOWN ARE THE MOST CRITICAL FOR THEIR RESPECTIVE CASES.

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
DWN BY:	CAE
CHK'D BY:	MGS
DATUM:	
PROJECTION:	
SCALE:	
PROJECT	ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS
TITLE	MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN SLOPE STABILITY ANALYSIS MAXIMUM HEIGHT SECTION SOUTH SIDE
REV. NO.:	A
DATE:	6/17/10
PROJECT NO:	3-2106-0174.0300
FIGURE No.	E-5

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

amec

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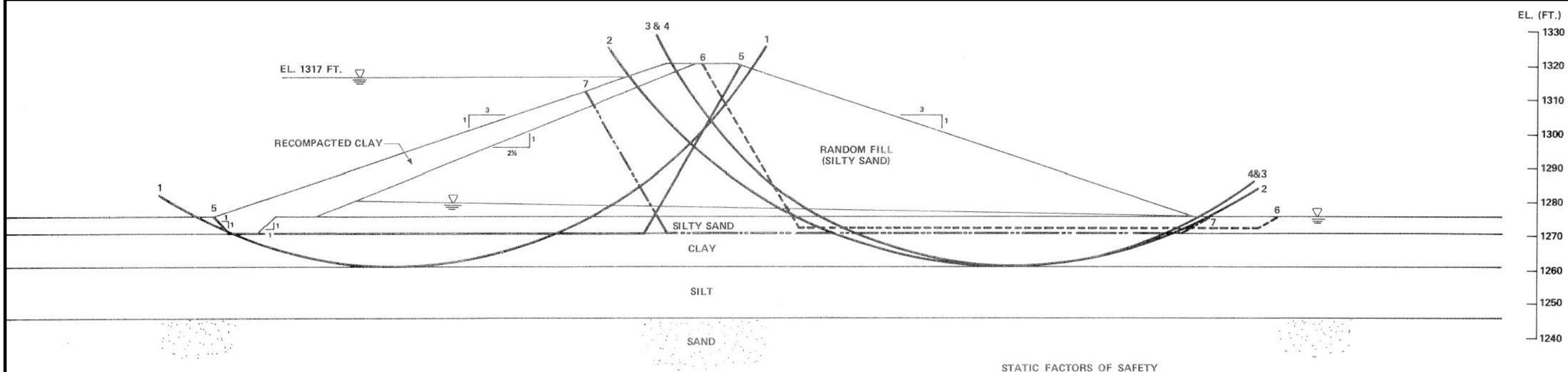

SEISMIC FACTORS OF SAFETY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
4	UNDRAINED	SEISMIC CASE (a_H = .05g, a_V = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.60
7*	UNDRAINED	SEISMIC CASE (a_H = .05g, a_V = .03g); POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.21

*FROM WEDGE ANALYSIS

SOIL PROPERTIES

SOIL / CASE	CLAY RECOMPACTED		RANDOM FILL (SILTY SAND)		CLAY IN-SITU		SILT IN-SITU		SAND IN-SITU	
	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)	C(psf)	φ(deg)
UNDRAINED	1000	0	500	30	900	0	500	30	0	40
DRAINED	500	20	500	30	350	20	500	30	0	40

STATIC FACTORS OF SAFETY

FAILURE SURFACE	SOIL PROPERTIES	COMMENTS	FACTOR OF SAFETY
3	UNDRAINED	SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	1.86
2	DRAINED	LONG TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.10
1	UNDRAINED	SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	1.86
6*	UNDRAINED	SHORT TERM CASE; POND WATER ELEVATION ASSUMED AT EL. 1317 FT.	2.18
5*	UNDRAINED	SHORT TERM CASE; POND EMPTY; CONSTRUCTION CASE	1.40

*FROM WEDGE ANALYSIS

NOTES:
1) THIS SECTION REPRESENTS A LOCALIZED LOW AREA ALONG THE EAST SIDE, THEREFORE THE HIGHEST EMBANKMENT ABOVE NATURAL GROUND.
2) FAILURE SURFACES SHOWN ARE THE MOST CRITICAL FOR THEIR RESPECTIVE CASES.

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	DWN BY: CAE CHK'D BY: MGS	PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS
AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	DATUM: PROJECTION: SCALE:	TITLE: MINNESOTA POWER BOSWELL ENERGY CENTER, COHASSET, MN SLOPE STABILITY ANALYSIS MAXIMUM HEIGHT SECTION EAST SIDE

REV. NO.: A
DATE: 6/17/10
PROJECT NO: 3-2106-0174.0300
FIGURE No. E-6

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APPENDIX F
INVENTORY OF PROVIDED MATERIALS

Documents Provided By Minnesota Power

1. Operation and Maintenance Plan For The Boswell Energy Center Ash Ponds, December 2005;
2. Clay Boswell Steam Electric Station Ash Disposal Ponds General Maintenance Plan;
3. Ebasco Services, Minnesota Power and Light Company, Clay Boswell Steam Electric Station, Unit No. 4 Ash Disposal Pond, Dike and Foundation Studies, Engineering Report, April 1977;
4. Ebasco Services, Minnesota Power and Light Company, Clay Boswell Steam Electric Station, Unit No. 4 Ash Disposal Pond, Dike and Foundation Studies, Engineering Report Addendum No. 2, October 1977;
5. BARR Engineering, Unit 3 Dry Ash Placement and Incremental Closure Plan, Boswell Energy Center, August 2007;
6. Ebasco Services, Minnesota Power and Light Company Clay Boswell Steam Electric Station, Unit No. 4, Wastewater Holding Basins Seepage Study, December 1977;
7. Drawing MINN 5159 M-4670, Ash-Handling System Ash Ponds Misc. Structures Sect and Det M&R SH. 3;
8. Drawing MINN 5159 M-4671, Ash-Handling System Ash Ponds Misc. Structures Sect and Det M&R SH. 4;
9. Minnesota Power Boswell Energy Center, BEC3 Ash Pond Piping Project, March 23, 2009;
10. William Stejskal, Minnesota Power and Light Company, Clay Boswell Steam Electric Station Units No. 1-4, Ash Disposal Ponds, September 2003;
11. Boswell Energy Center, Industrial Waste Disposal Facility, Monthly Inspection Reports 6-24-05 to 6-9-10;
12. Boswell Energy Center, Hibbing Ash Cell Log, Monthly Logs 4-9-06 to 6-9-10;
13. 1956 Boswell MDNR Water Appropriation Permit;
14. 1971 Boswell MDNR Water Appropriation Amendment;
15. Ebasco Services Minnesota Power, Clay Bowell SES, Pond Closure and Sealing Plan Unit #3 Fly and Bottom Ash Ponds, August 1981;
16. Crest Survey Elevation for Active Ash Pond Complex and Inactive Bottom Ash Pond, May 20, 2010;
17. Sounding Data, Topographic Map, January 11, 2006;
18. Minnesota Power Response To EPA June 2009 Information Request;
19. Relationships between Active Clay Boswell Coal Combustion Byprodcut Impoundments and Power Plant Operations;
20. ICR Attachments 10A through 23D;
21. Email correspondence concerning 2009 BEC Dike Erosion Repairs June 23, 2009;
22. Email correspondence concerning BARR Engineering findings regarding dike cracking, April 8, 2008;
23. BARR Engineering, Ash Pond Embankments – Spring 2009 Inspection Report, July 14, 2009;
24. Minnesota Department of Natural Resources, 2009 inspection of Clay Boswell Ash Dams, November 9, 2009;
25. Boswell Energy Center Ash Disposal Ponds and Location of Groundwater Monitoring Wells;
26. Sewer Shed Map of CWWTF (Central Waste Water Treatment Facility);
27. Boswell Energy Center Stormwater Sample Locations;

28. Boswell Images Including: 2008 airphoto, EPA-NWI, topo, topo-NWI (files could not be opened);
29. Diagram 1 (SW10-SW 14 and HW1 – HW4);
30. Diagram 2 (PW1-PW7 and CW1 – CW4);
31. Diagram 3 Boswell Energy Center Storm Water Runoff Diagram;
32. Diagram 3a Storm Water Sewer System Area;
33. Boswell Energy Center Modified Stormwater Drain Plan;
34. Map 1 Boswell Energy Center General Site Map;
35. Map 1 Boswell Energy Center General Site Map (Different from item 34);
36. Map 2 Boswell Energy Center National Wetlands Inventory;
37. Map 3 Coal Ash and Industrial Solid Waste Disposal Areas;
38. Map 3 Groundwater Monitoring Wells;
39. Map 4 Cooling Water Area;
40. Map 5 Process Wastewater;
41. Map 5a Central Wastewater Treatment Facility Sewershed;
42. Map 6 Solid Waste Accumulation Areas;
43. Ash Pond Elevations 2005 – 2010;
44. Groundwater Elevation Summary 2006 – 2010;
45. BARR Engineering, BEC Ash Pond Dams – Movement Monitoring Station Data Review, December 11, 2009;
46. Survey Monitoring Data;
47. Boswell Energy Center Ash Pond Piping Dimensions (Included Active Ash Pond Complex, WWTP, and Inactive Bottom Ash Pond);
48. Minnesota Power and Light Company Clay Boswell Steam Electric Station, Flow Diagram, Ash Handing Sheet 3, MINN 5159, M 1027C;
49. Minnesota Power and Light Company Clay Boswell Steam Electric Station, Flow Diagram, Wastewater Treatment Facility Sheet 4, MINN 5159, M 8711B;
50. Minnesota Department of Natural Resources, Amendment to Permit 56-197, Dated November 28, 1995;
51. NPDES Permit Renewal Application dated May 21, 2010;
52. Minnesota Pollution Control Agency, NPDES Permit MN0001007, Dated March 9, 2007;
53. Minnesota Department of Natural Resources, addendum to existing permit 56-197, dated May 8, 1978;
54. Information Summary for Minnesota Power Boswell Energy Center Ash Ponds;
55. Enclosure 1, Allete, Inc Boswell Energy Center, EPA CERCLA Section 104(e) Information Request for Surface Impoundments March 2009;